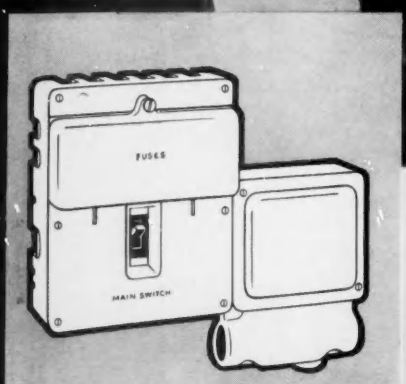
18 MARCH 1954

NINEPENCE

# ELECTRICAL TIMES

FLEXIBILITY of arrangement to suit all domestic installations




**FUSEWAYS INTERCHANGEABLE — unused ways shielded.** The eight ways can be arranged in any desired sequence (5, 15 and 30 A) by use of the appropriate turrets which are interchangeable in the bases. The turret prevents householder inserting the wrong fuse carrier. Blanking covers shield unused ways.

**COLOUR AID TO FUSING.** Fuse-link, carrier and turret are coloured according to rating.

**SPARE CARTRIDGE FUSES** are kept in a handy compartment in the lid.

**ROBUST MAIN SWITCH.** HENLEY 60A Double-pole Slow-break Switch.

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**CONSUMERS' CONTROL UNITS**

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Benjamin lighting gives maximum ' visual comfort '
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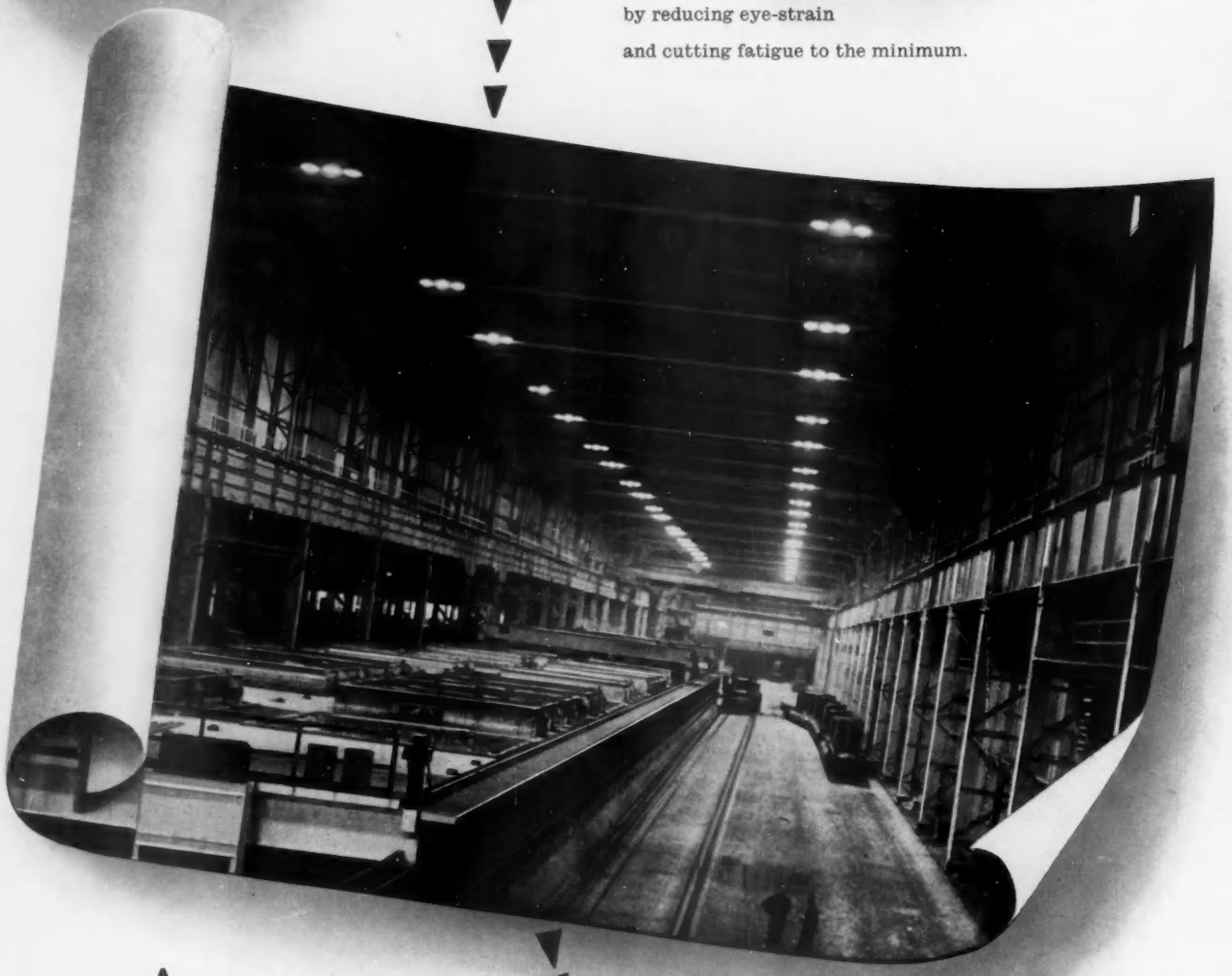

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an expert survey will be carried out,
every detail studied and
a plan submitted that will ensure—

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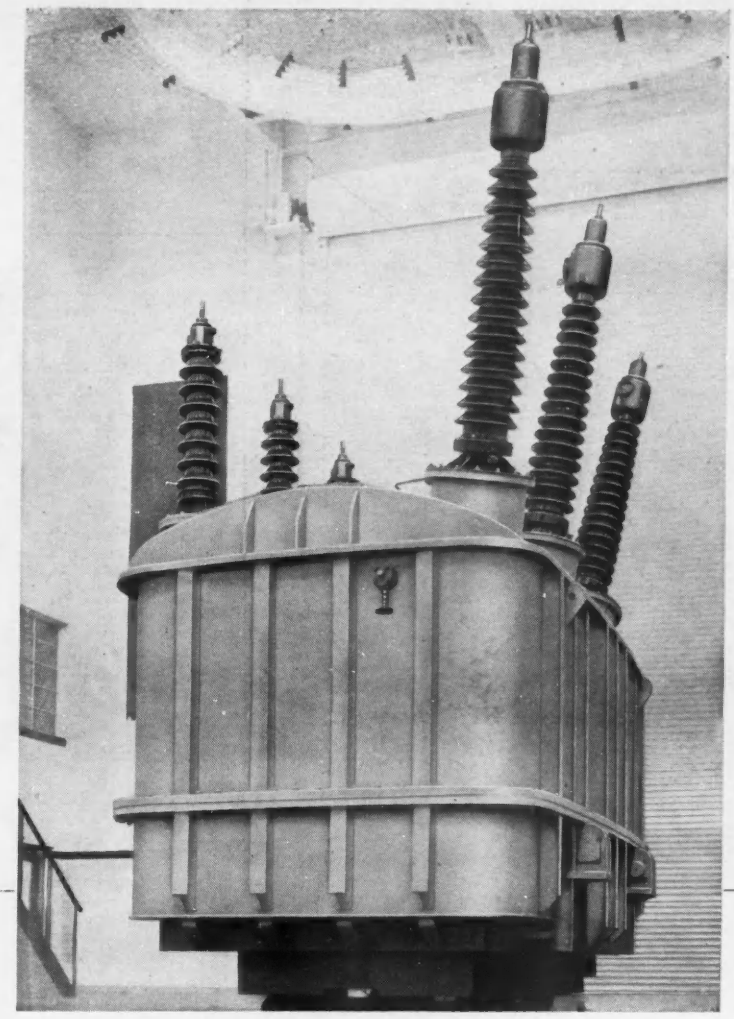
Smee's 154

# 230 kV Transformer earns U.S. Dollars



The first 230 kV transformer to be supplied from Great Britain to the United States of America has now been despatched from the Stafford Works of The ENGLISH ELECTRIC Company. It is a three-phase unit of 80 MVA capacity for the Folsom Dam Project on the Sacramento River in California, engineered by the U.S. Government Bureau of Reclamation.

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*Transformer Department, Stafford*

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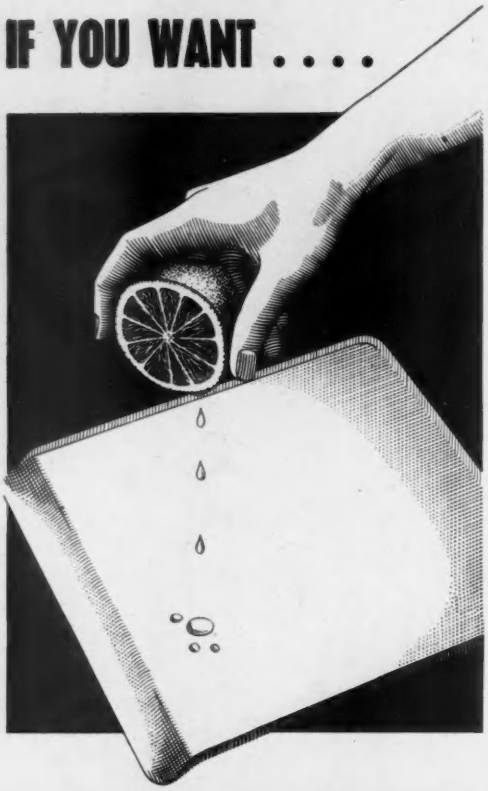

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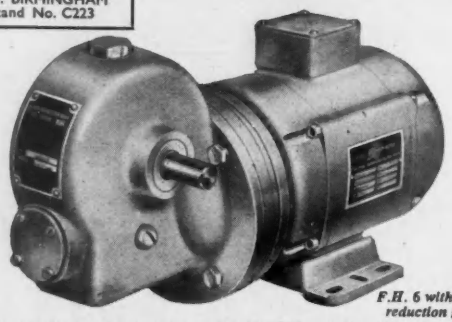

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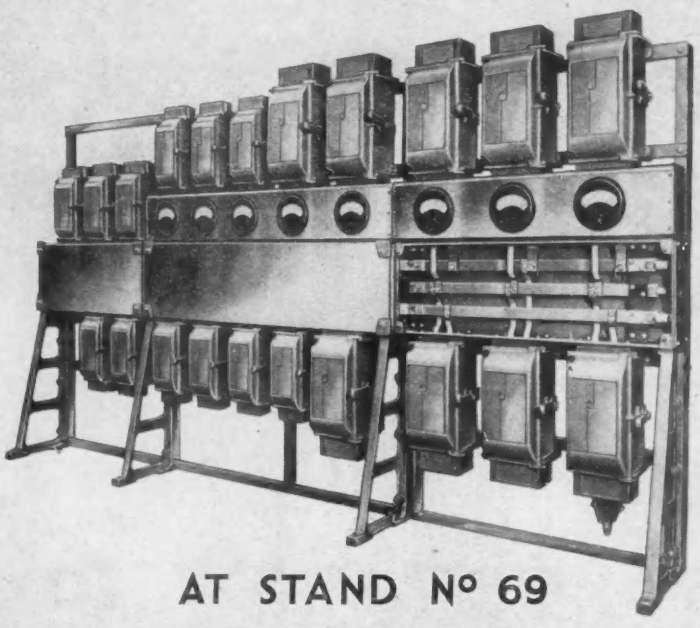

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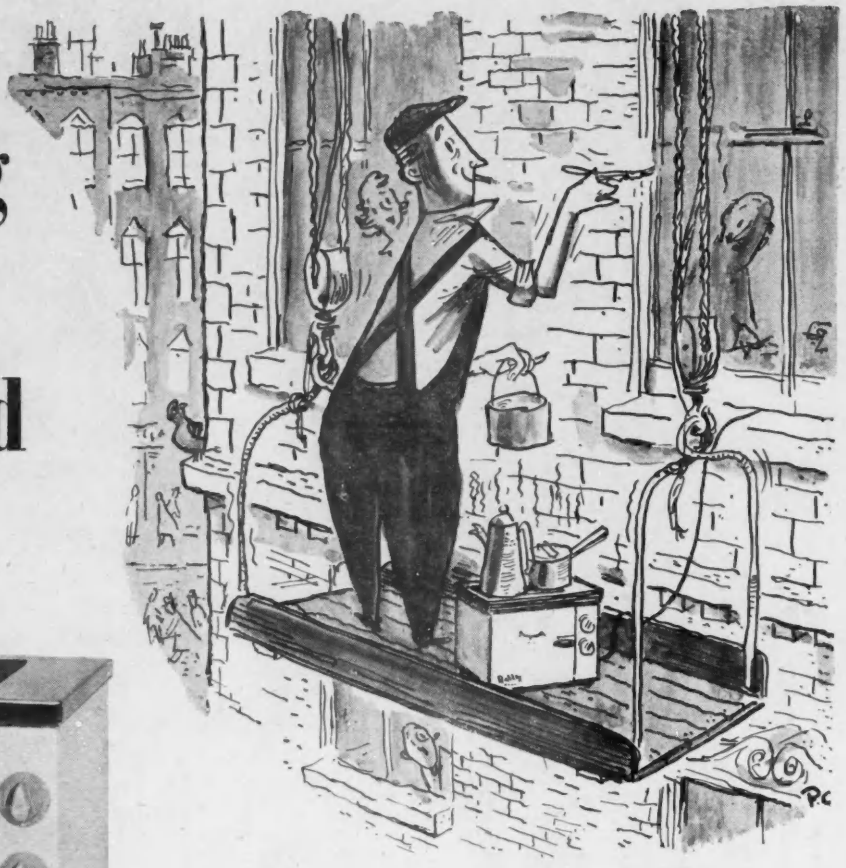

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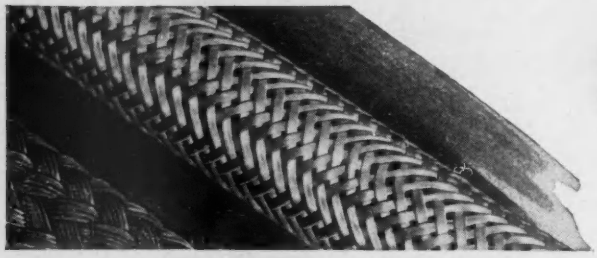

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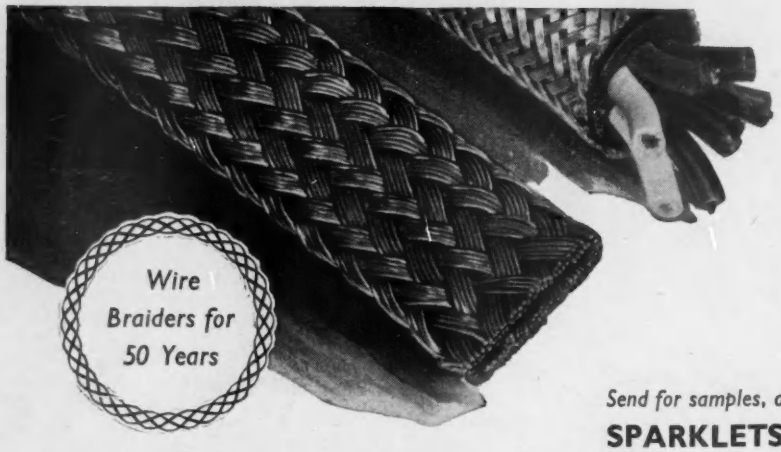


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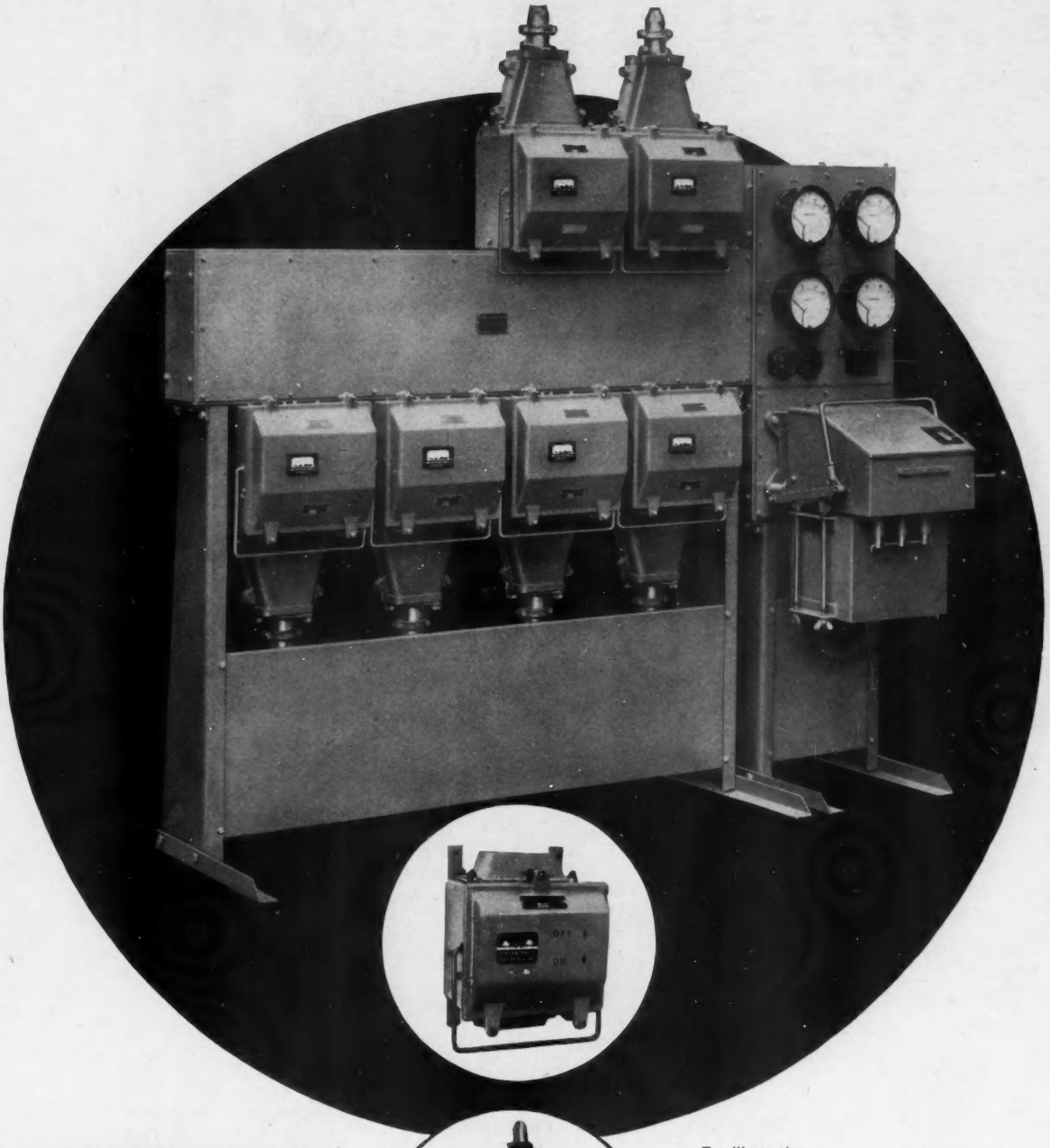

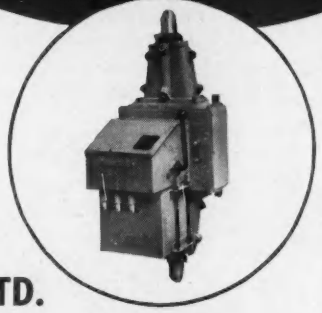

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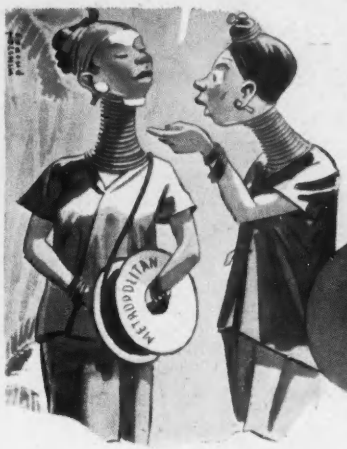


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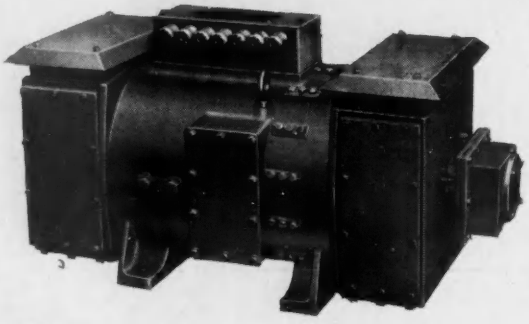

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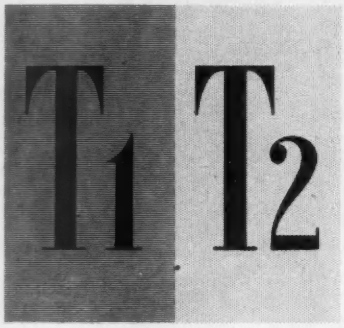


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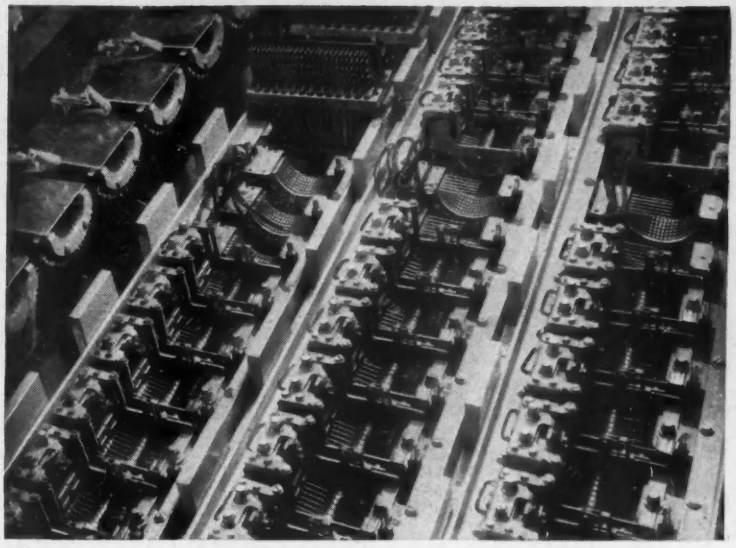

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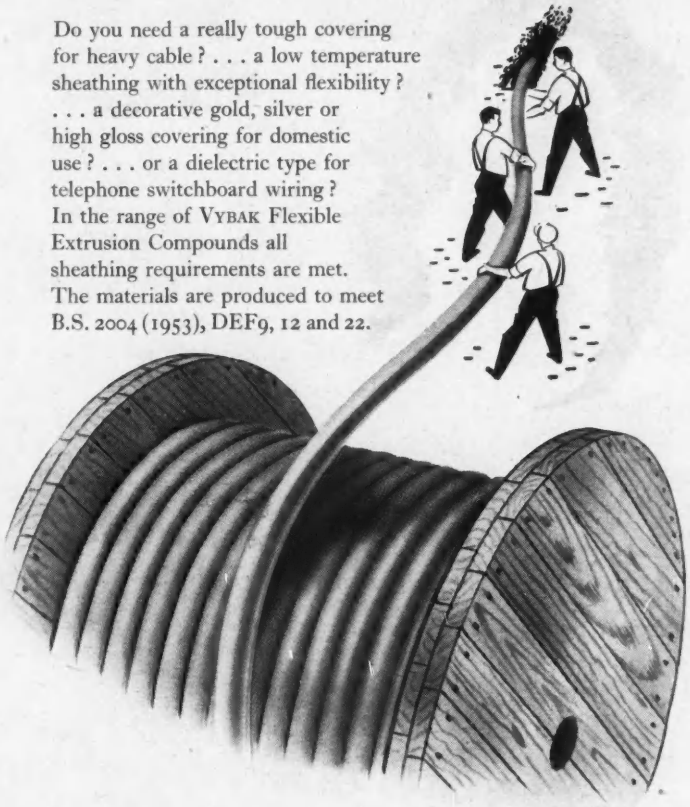

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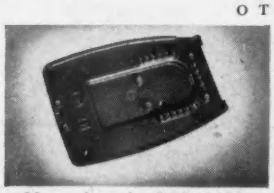
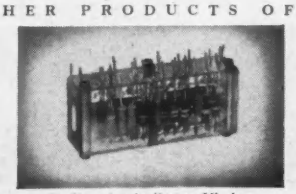
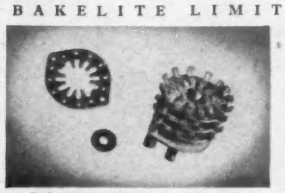


*Motor base in BAKELITE rubber-modified phenol c material*



*Radio circuit "potted" in BAKELITE Polyester Resin*



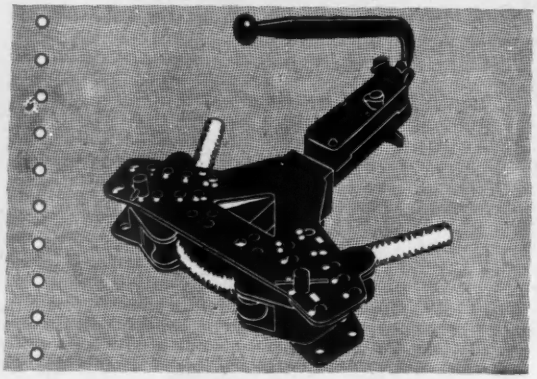
*BAKELITE Laminated is used for insulation of switches etc.*

*BAKELITE Cements bond the base to the cathode tube*

B

C3

# Bending Tubes



- Hydraulic Bending Machine (H.3)
- fitted with 180° Bending Attachment.
- Designed to bend cold and unloaded
- up to 180°, all classes of steam
- and gas tubing from ½"—2" i.d.
- Flat Bar Bending Attachment can be
- supplied for sections up to 4" x ½".
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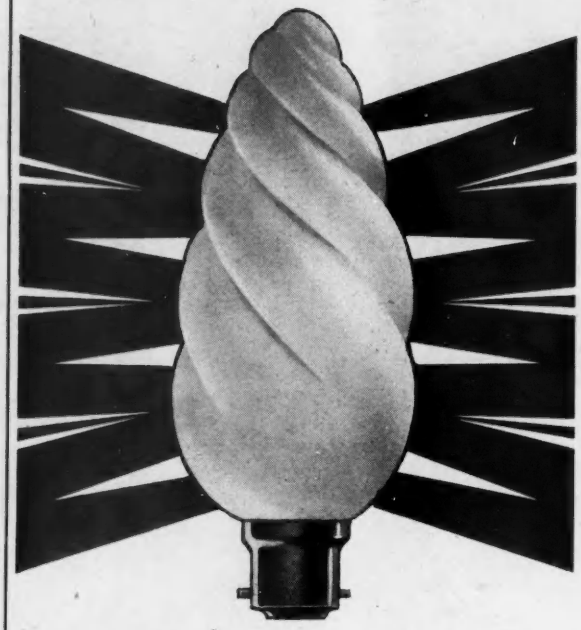

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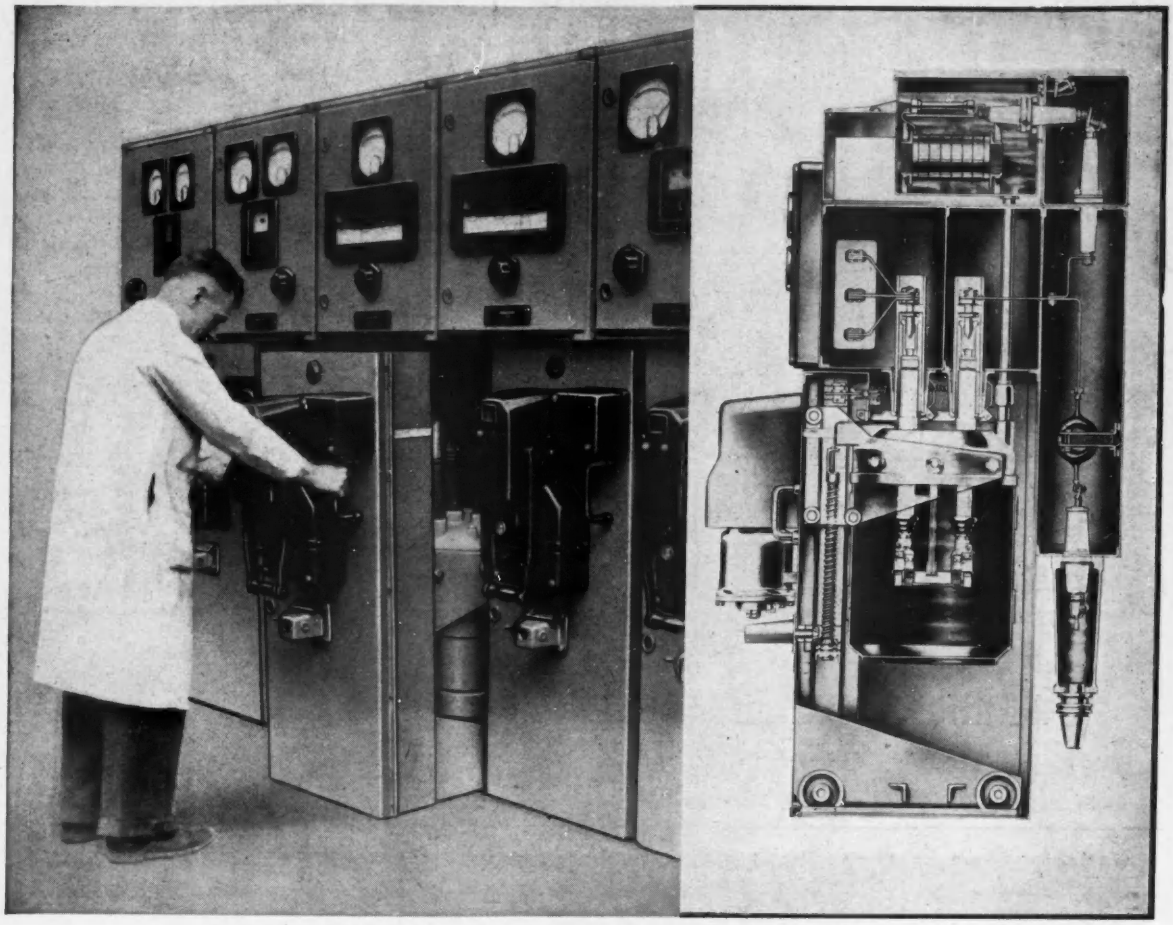

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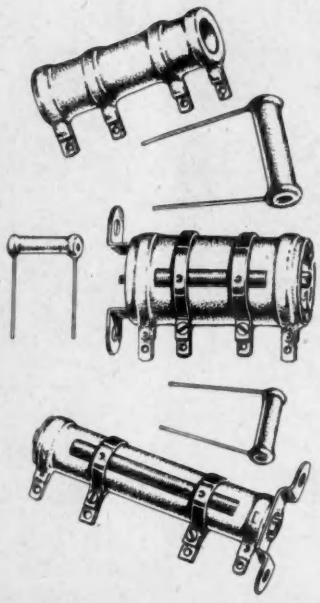

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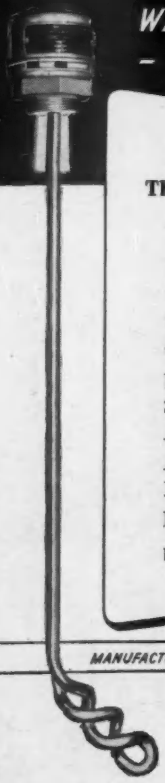

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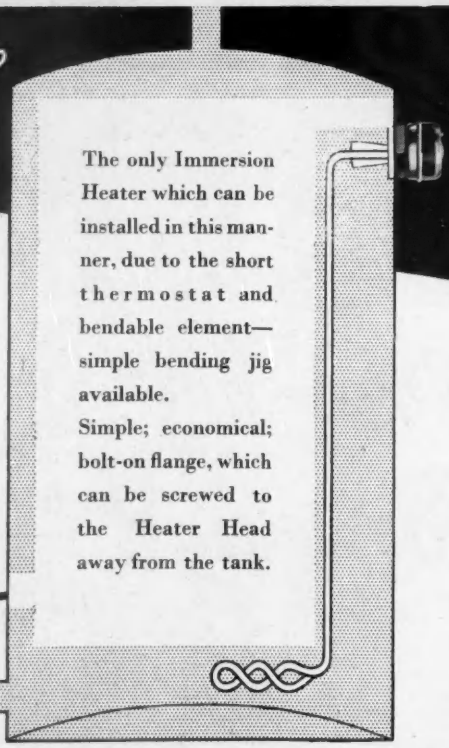

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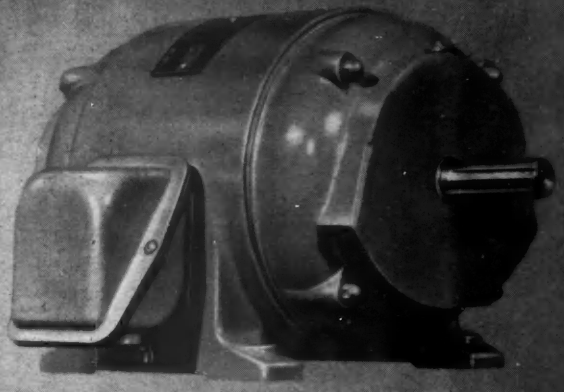

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| D.C. VOLTAGE | D.C. CURRENT | A.C. VOLTAGE | A.C. CURRENT | RESISTANCE |
|---|---|---|---|---|
| 2·5V. | 50μA. | 2·5V. | 100mA. | *First indication* 0·5Ω. |
| 10V. | 250μA. | 10V. | 1A. | *Maximum indication* 20MΩ. |
| 25V. | 1mA. | 25V. | 2·5A. | 0—2,000Ω { using internal batteries. |
| 100V. | 10mA. | 100V. | 10A. | 0—200,000Ω { using internal batteries. |
| 250V. | 100mA. | 250V. | — | 0—20MΩ { using internal batteries. |
| 1,000V. | 1A. | 1,000V. | — | 0—200MΩ { using external batteries. |
| 2,500V. | 10A. | 2,500V. | — | |

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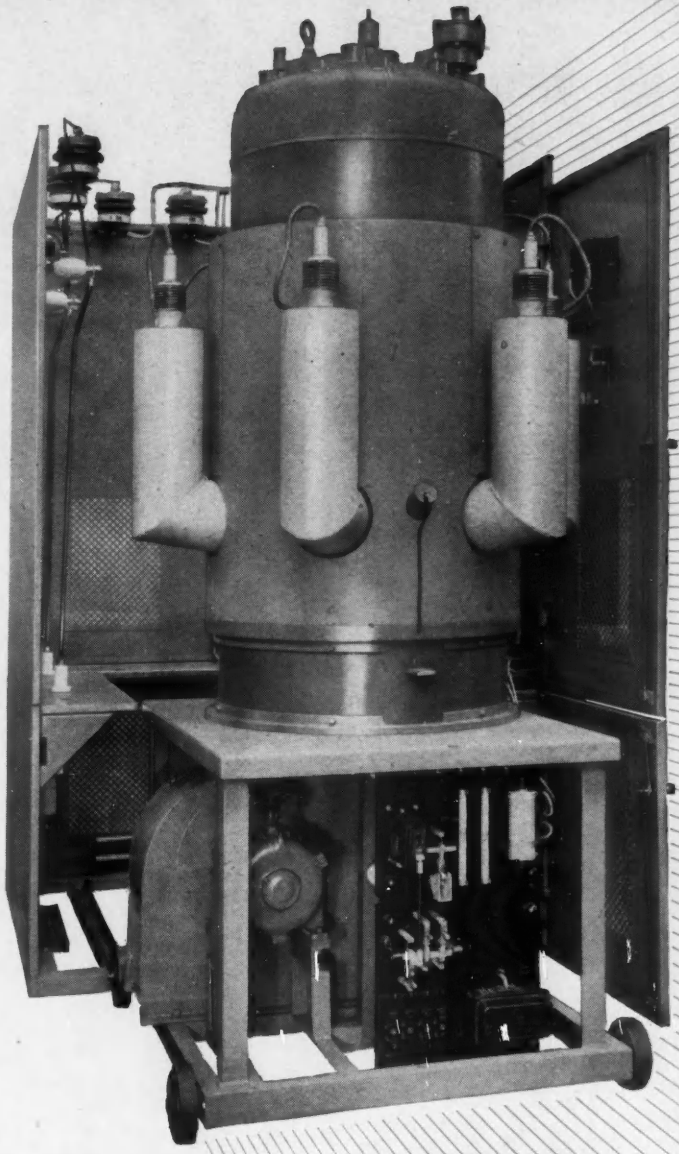

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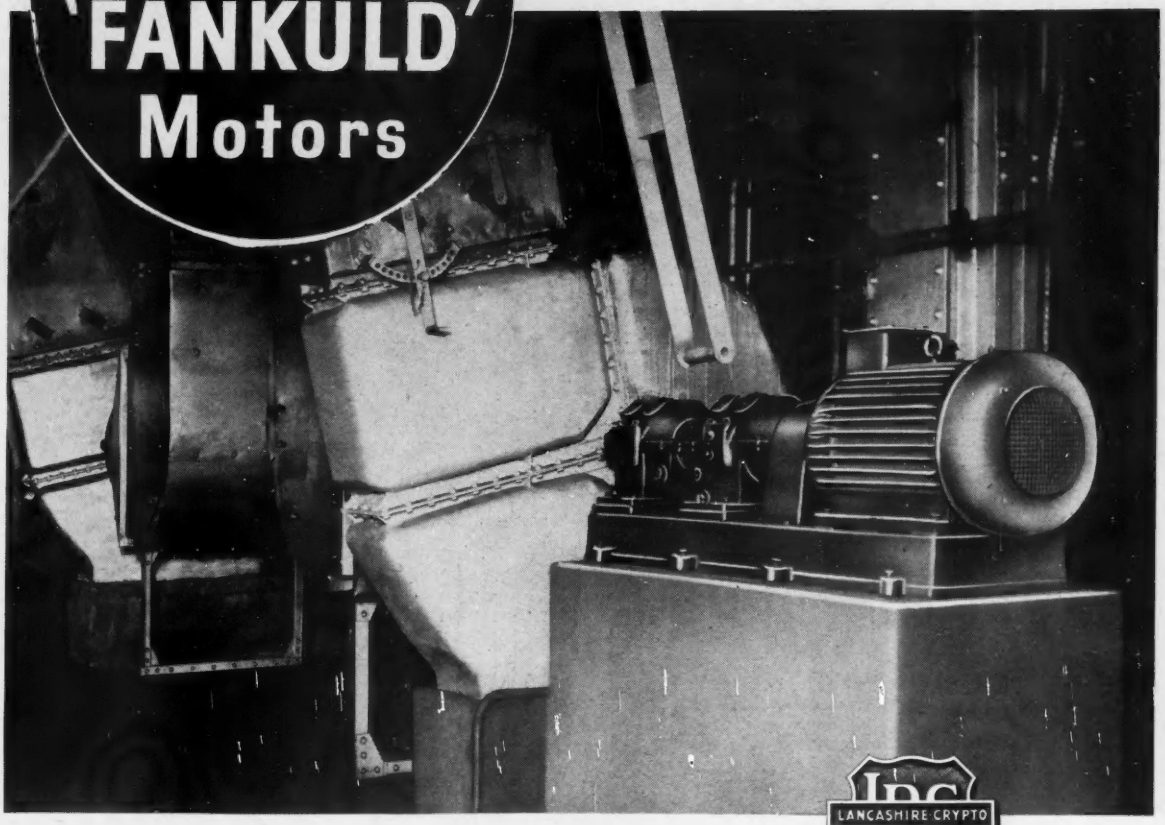

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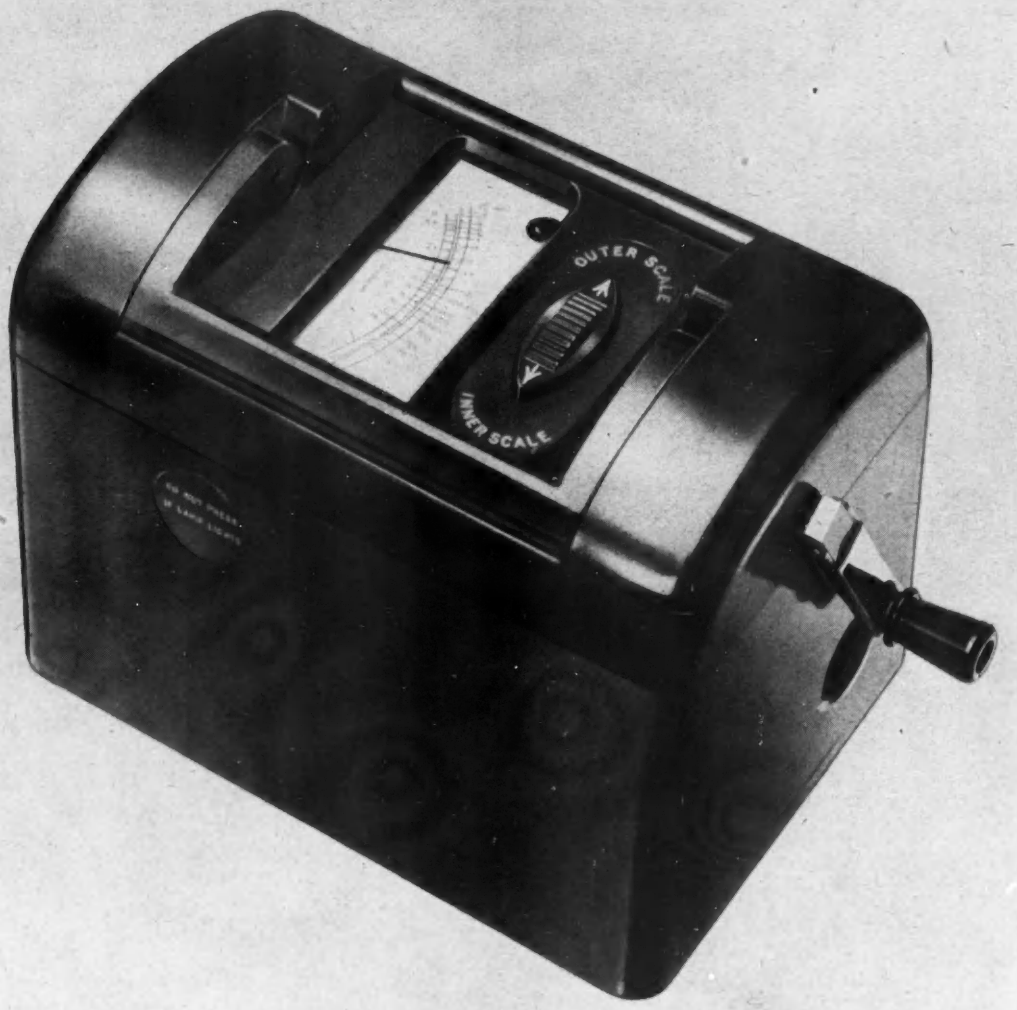


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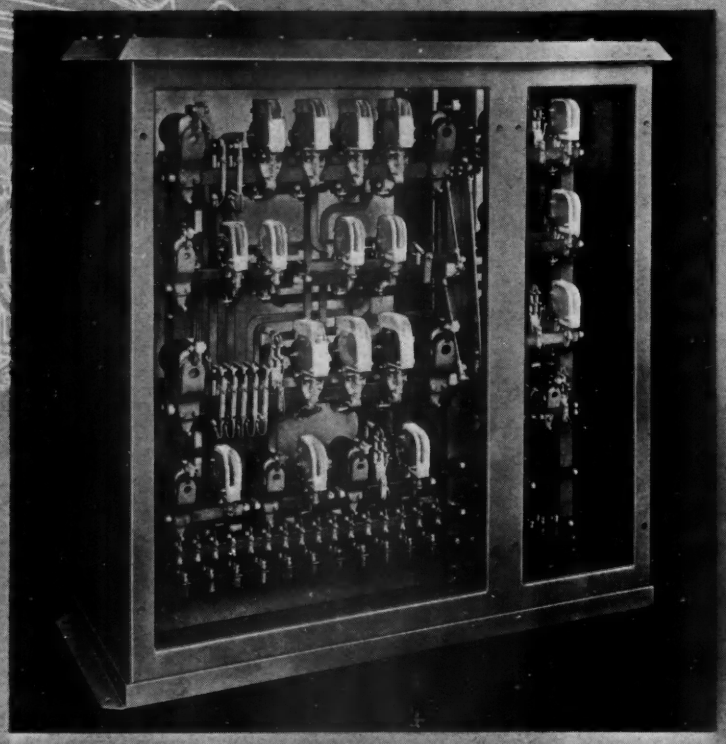

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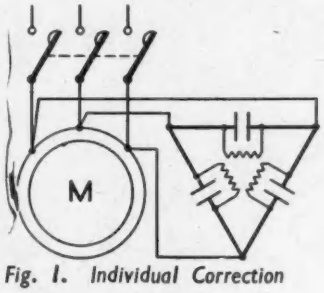

*Fig. 1. Individual Correction*

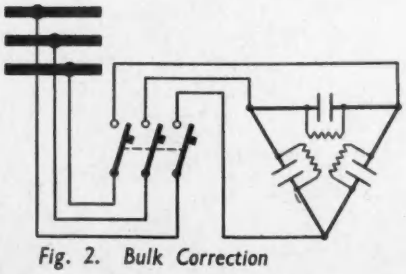
*Fig. 2. Bulk Correction*

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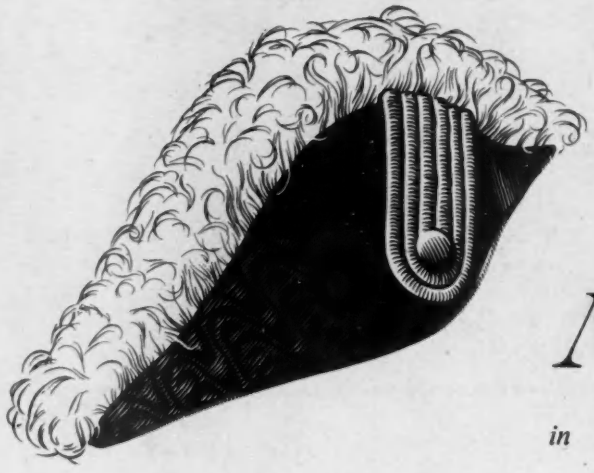

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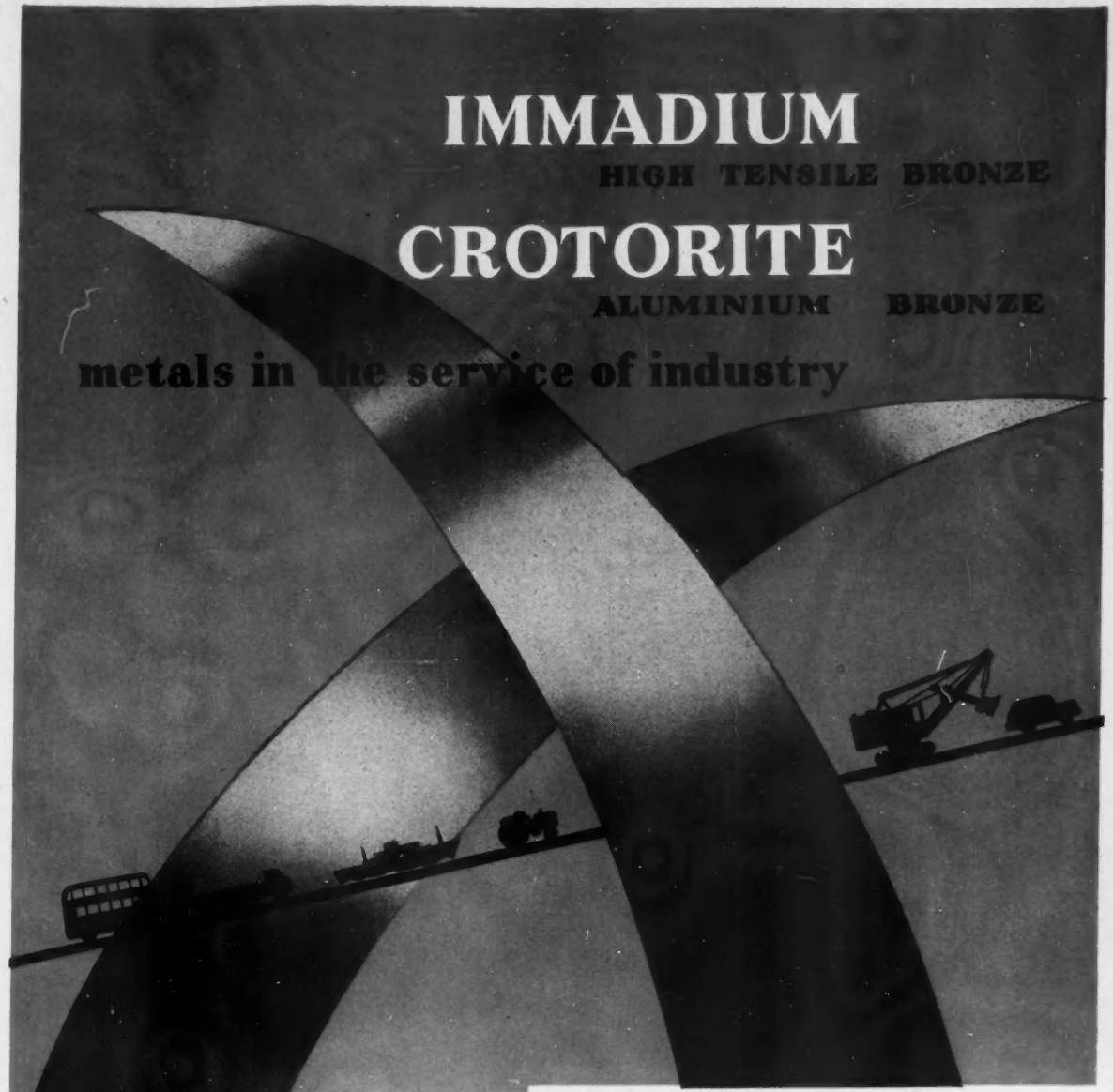

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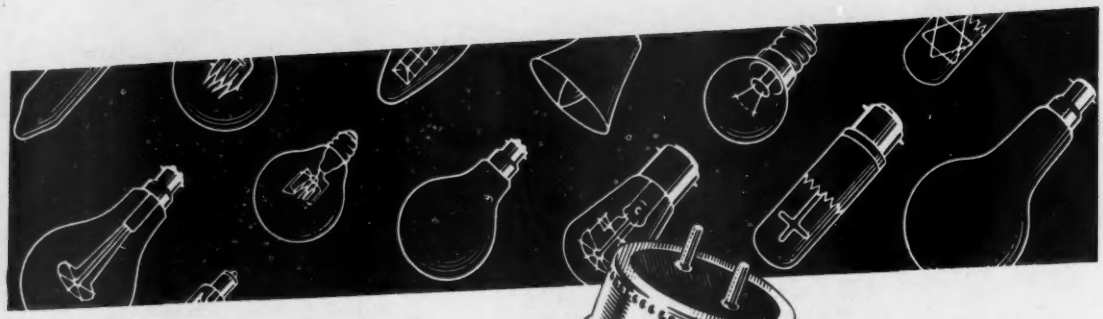
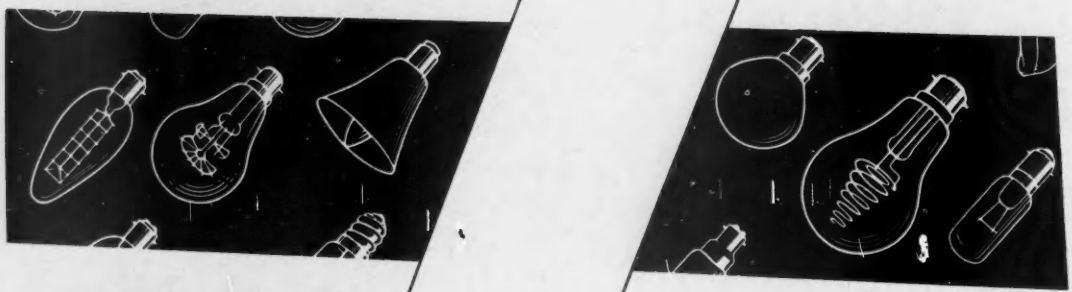


LAMPS and TUBES



ATLAS

*Illustrated literature and price lists for all forms of ATLAS lighting are available from:*

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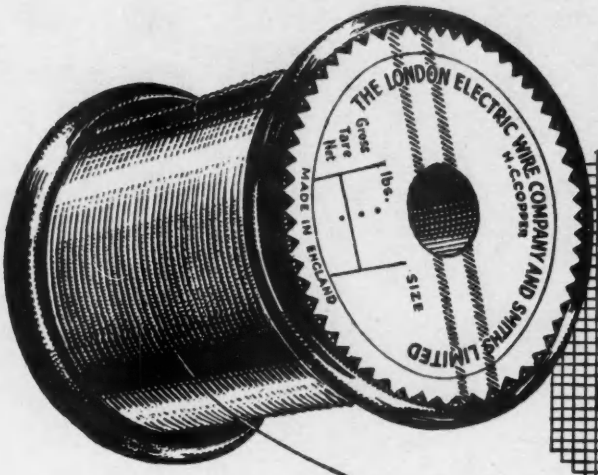


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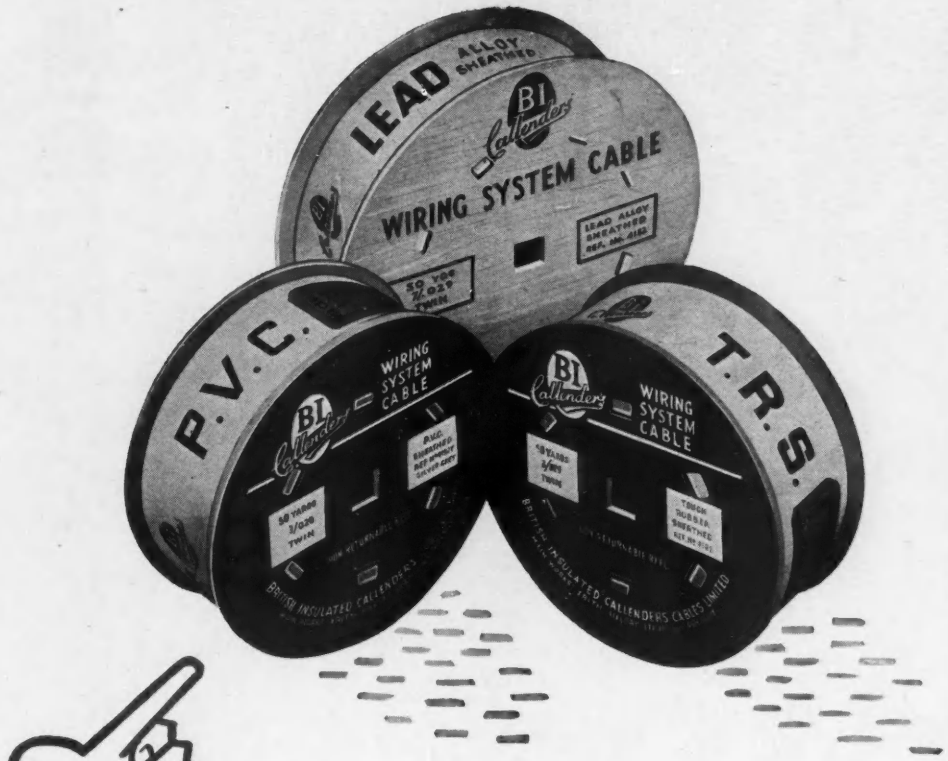


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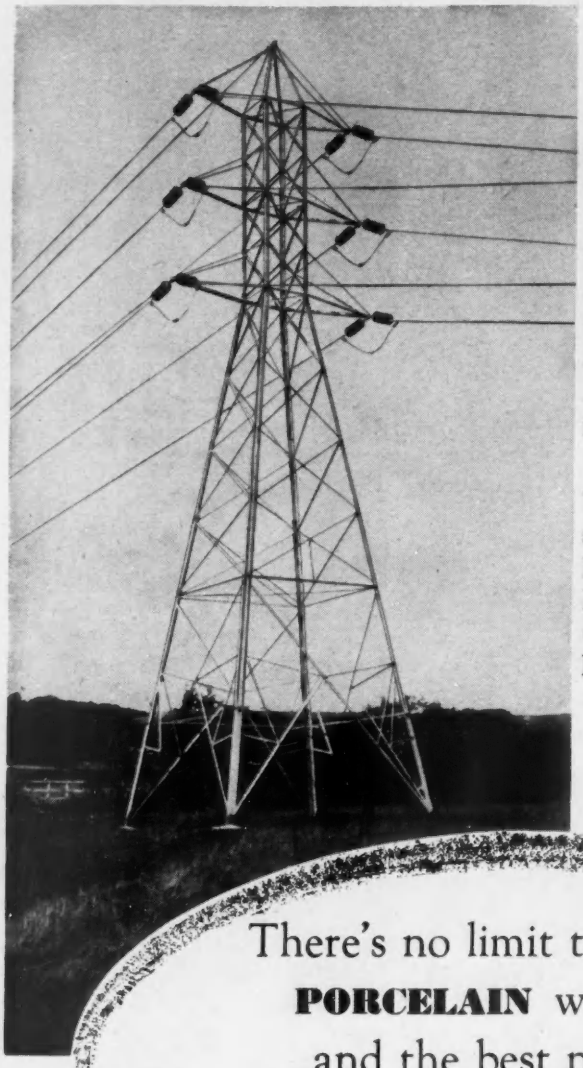

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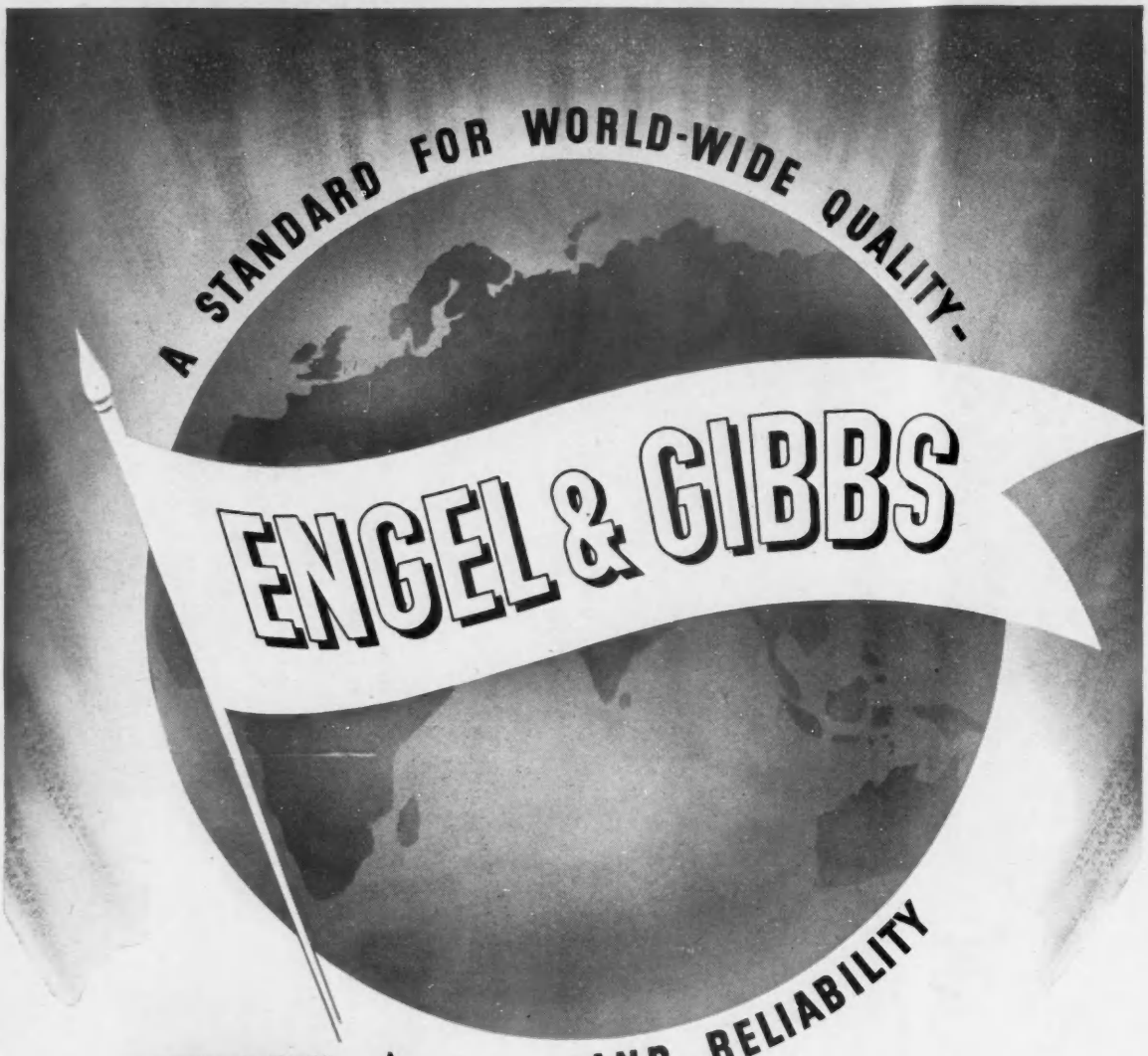

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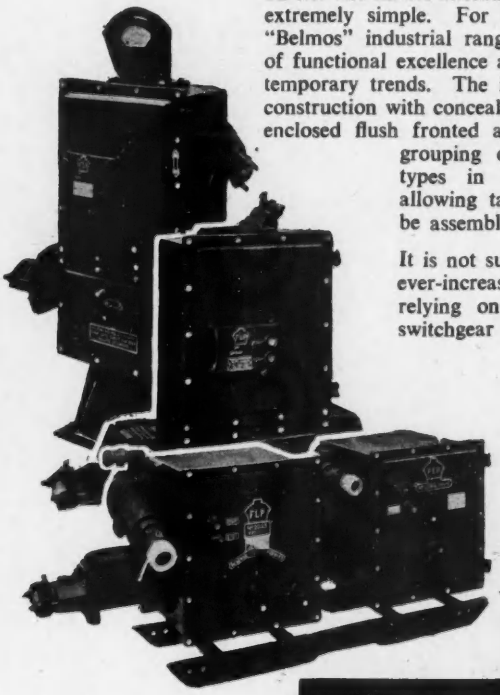

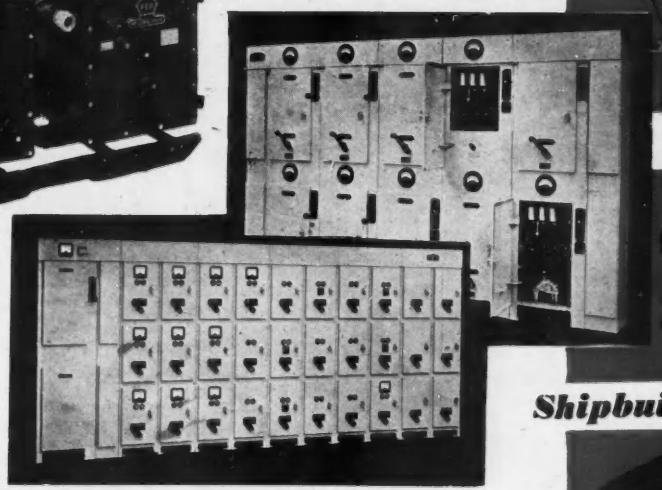

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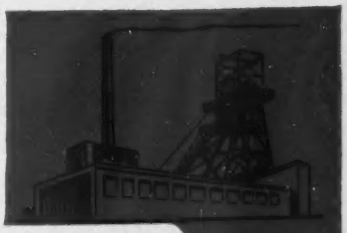

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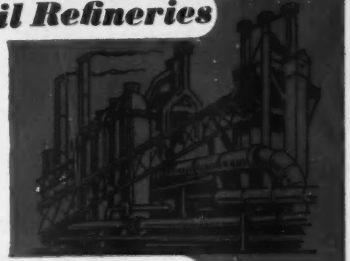

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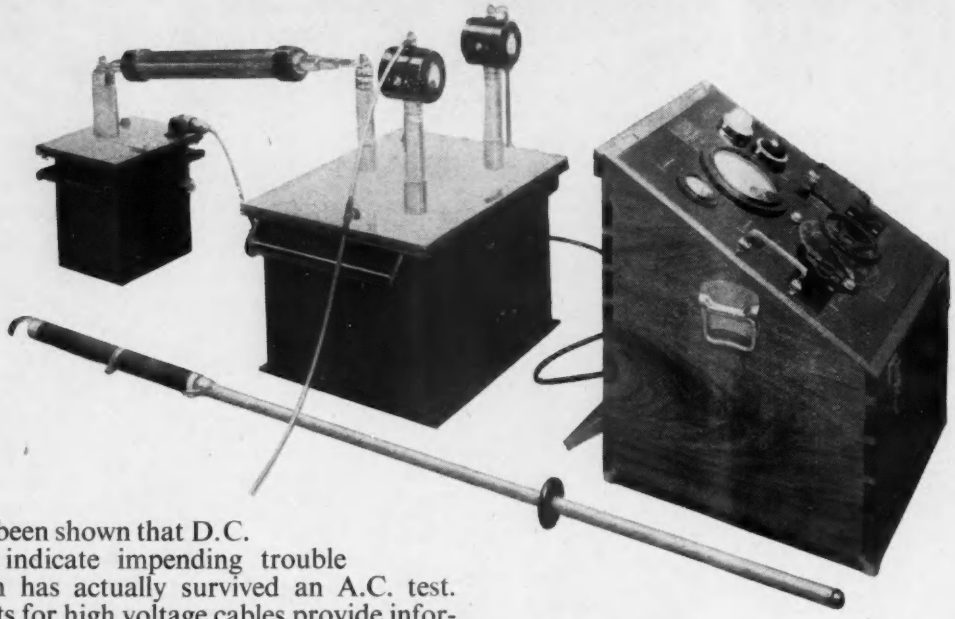

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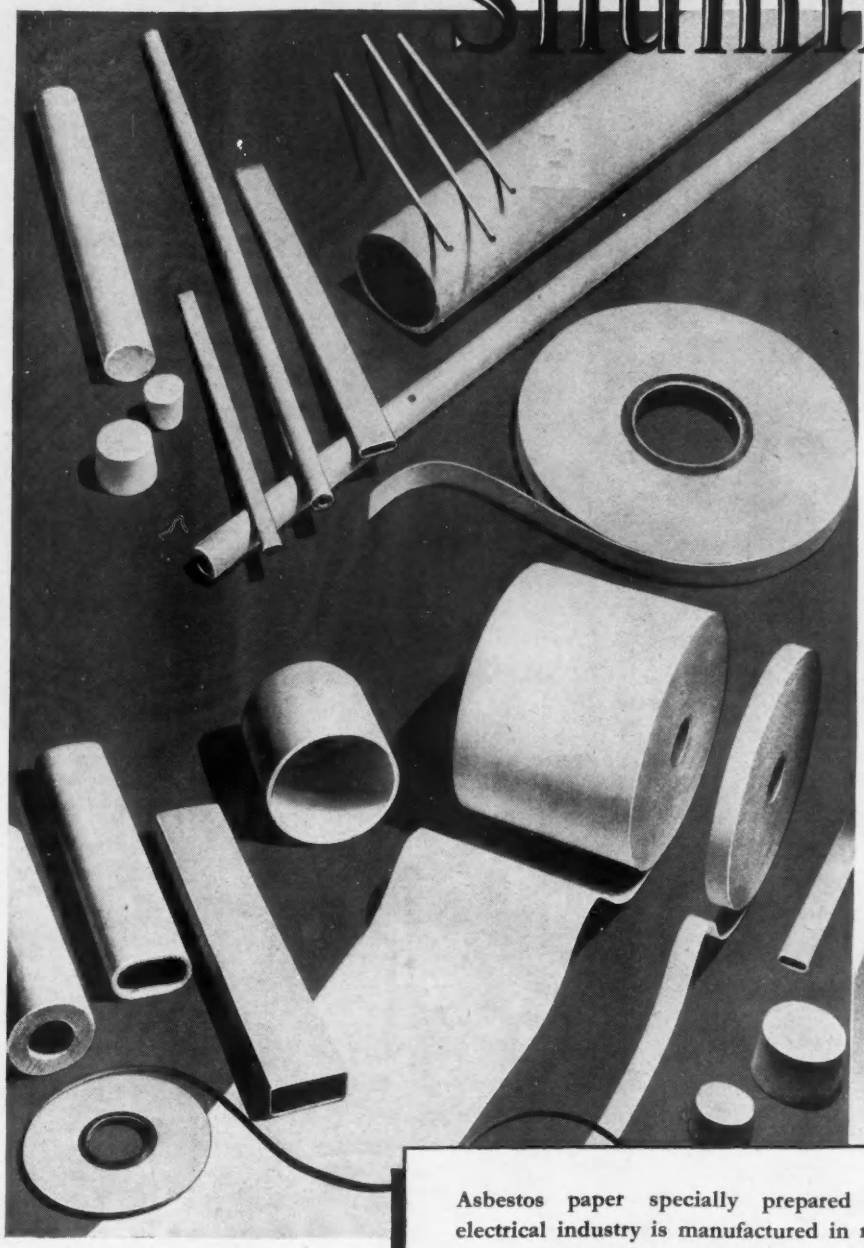

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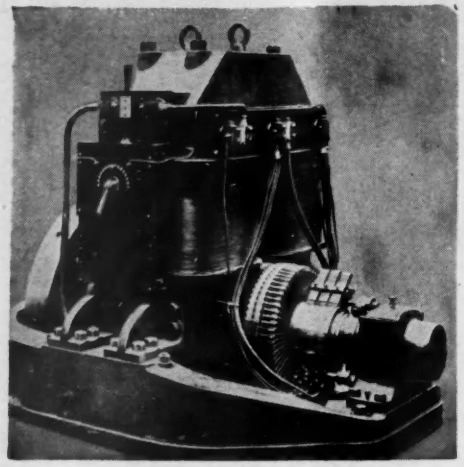

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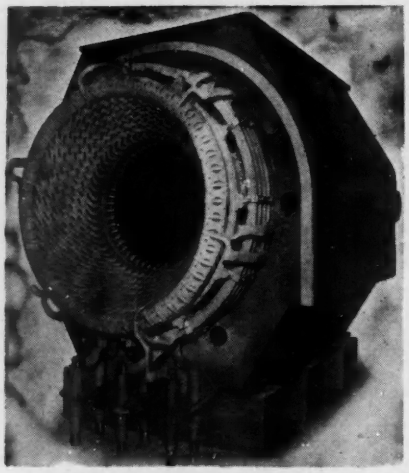

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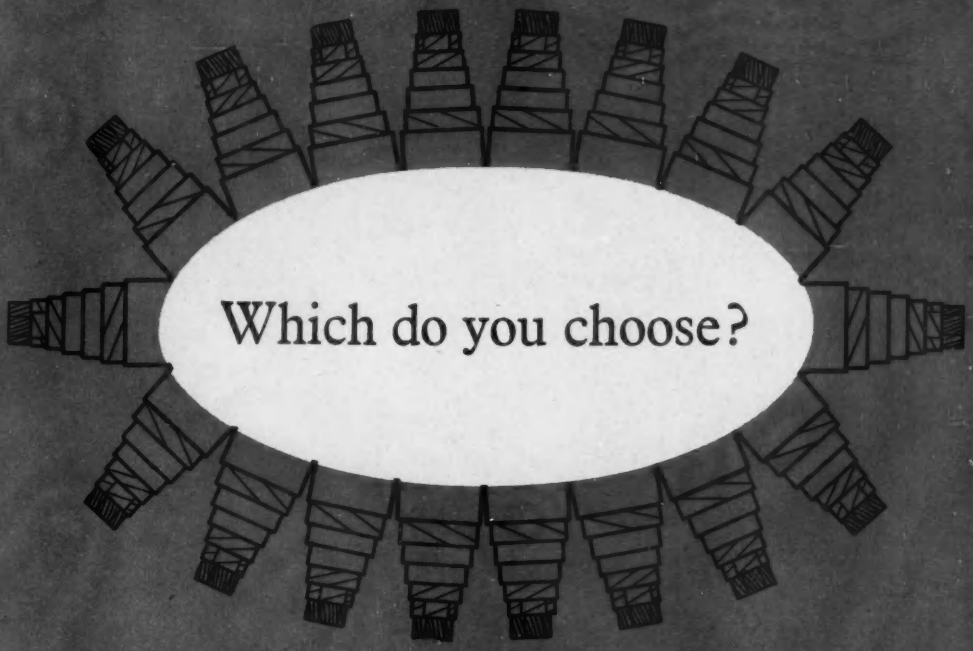


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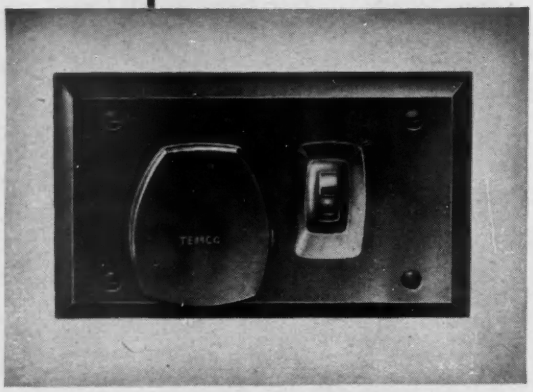


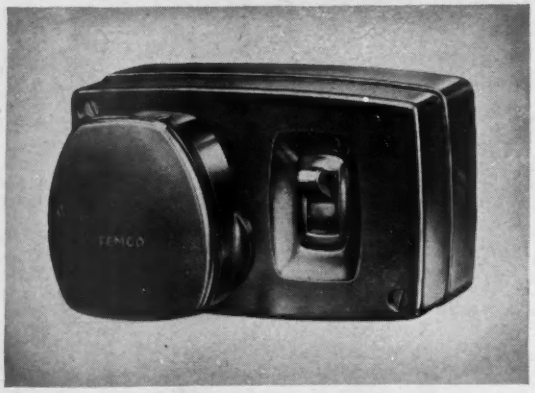


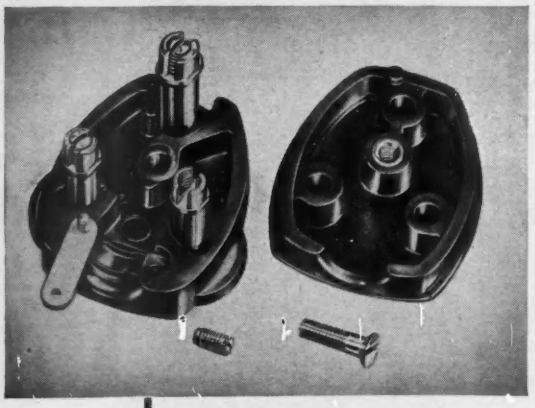

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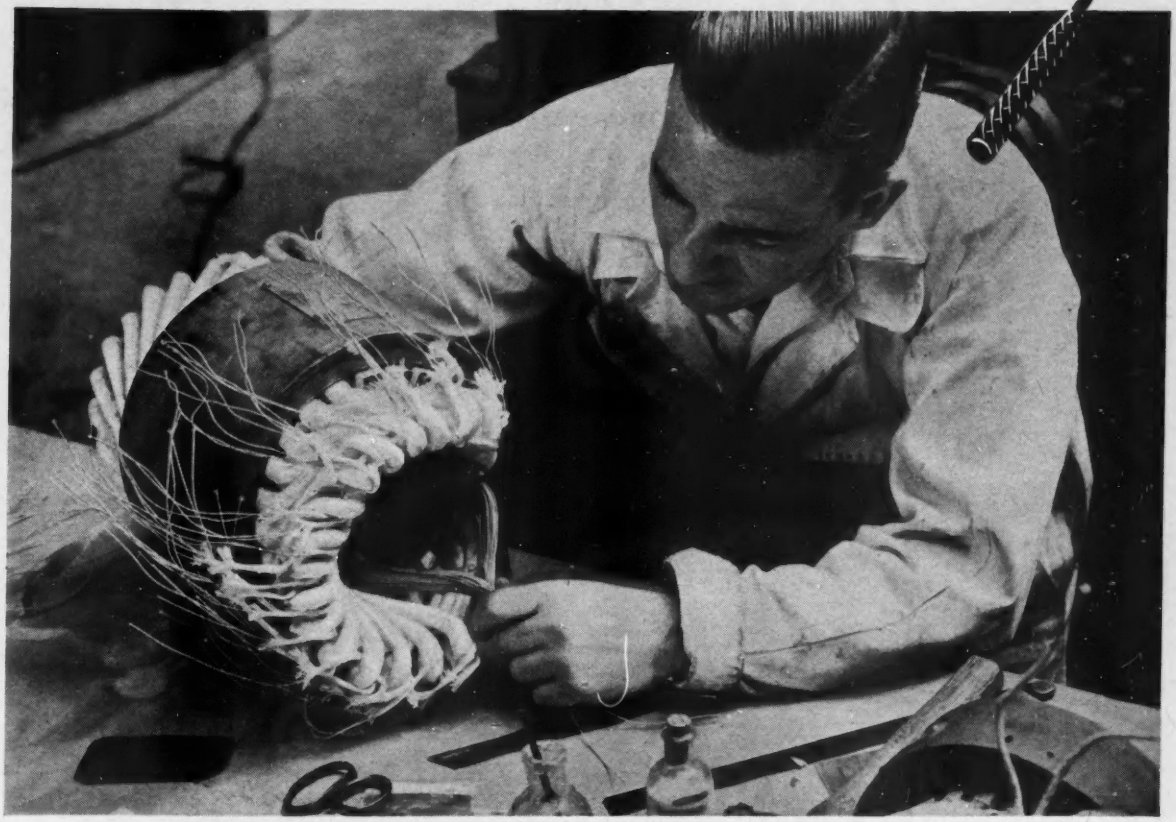

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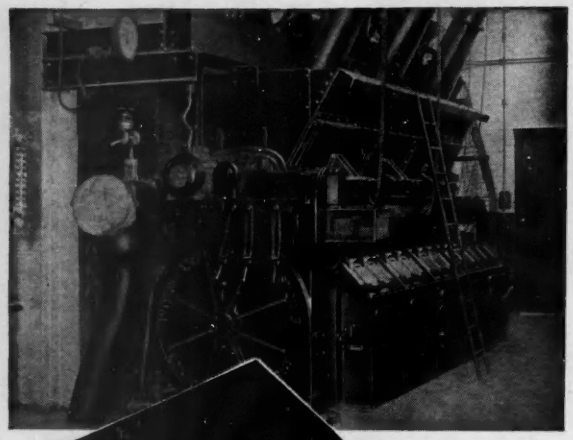

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THURSDAY, 18 MARCH, 1954
Volume No. 125 Number 3254
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## DEMAND FROM ALUMINIUM

To produce one pound of aluminium requires from eight to nine and a half kWh of electrical energy, and with world production running at about 2·6m tons per year, this means that $50 \times 10^9$ kWh of electricity are being generated annually for the electrochemical processing of this metal; a total of the same order as the yearly generation by all B.E.A. power stations. Moreover, since world demand for aluminium is on the increase, the production figures are likely to rise sharply in the immediate future, a recent U.N. report suggesting 3·5m as the figure for 1955 and envisaging a possible 4·5m tons per year by 1960. Even when the high load factor of aluminium processing is taken into account, this extra demand of some $40 \times 10^9$ units clearly represents a substantial proportion of the coming decade's demand for new plant, and the question of the form in which this will be required must be exercising manufacturers' minds. At present, of course, the electricity used in aluminium production is predominantly hydro based, but there are already some notable and perhaps significant exceptions. In the United States, considerable use has been made of reserves of natural gas to fire steam power stations that supply the aluminium works' electricity requirements, and in the U.S. again and in Hungary deposits of lignite are being developed for this same purpose. No doubt other instances will occur of conventional steam stations serving aluminium plants, but with nuclear power production on the horizon, a more interesting possibility is beginning to exercise its influence on the siting of aluminium production. Electrolysis on this scale would be a load well suited to the economics of atomic electricity, and the building of nuclear reactor power stations might prove a less expensive project than the development of large civil works for a hydro scheme in some isolated spot. With the long term possibilities of aluminium now under consideration, this point deserves attention.

## SCIENCE IN PRODUCTION

Everyone knows that British industry is blameworthy for its lack of enterprise in not making reasonable use of scientific discoveries. This is widely accepted as an unarguable and generally agreed premise from which to launch after-dinner speeches and chapters of reproof in official reports. It comes as a welcome surprise, then, to find that an investigation into a representative selection of firms in the Manchester area should record a dissenting opinion, and conclude after a general survey of many day to day applications of scientific knowledge, often accompanied by close contact

with appropriate departments of some university, that "in certain fields of British industry, the resources of science are most effectively enlisted to aid and support industrial progress." The investigation was undertaken jointly by Manchester's university and Chamber of Commerce, with the blessing of the Department of Scientific and Industrial Research, and it was selective only in its concentration on the Manchester area and on medium to large-sized firms: those employing more than fifty workpeople, but not having a country-wide manufacturing organisation. Of such firms it judged that one-third did not require much from science, while another third required mainly the steady and efficient application of well-established principles. Naturally there is adverse criticism as well as praise, but the conclusions remain in sharp contrast to what was generally expected. Other surveys of this nature have been conducted directly by D.S.I.R. and the results of these, when available, should combine with the Manchester report to provide guidance on a subject whose importance is being underlined by a current television series of programmes.

## NEW NAMES FOR METERS

When a revision of the British Standard for indicating meters appeared in 1937, the old second-grade meter was excluded from recognition, but the terms sub-standard and first-grade were somewhat illogically retained to describe the remaining classes. Now F.G. is to be no more; a new revision has replaced this time-honoured term by the more appropriate "industrial," while sub-standard becomes, a trifle invidiously, "precision." The new classification was remarkably closely foreshadowed in the foreword to the 1937 revision, which explained with some care that its own divisions had been adopted "as a compromise between two schools of thought, of which one lays the greater stress on the highest attainable accuracy, and the other on robust construction and minimum cost." In fact, in the new standard, the limits of error are fixed as finely as ever, while, as is appropriate with the great advances in instrument design from departure made possible by the availability of new materials in recent years, the permissible errors arising from standard conditions of temperature, frequency and so on, are in many cases reduced.

## INCENTIVES IN MAINTENANCE

Incentive payments are a thoroughly established and accepted feature of present industrial practice, and in most factories an appreciable proportion of the workpeople have an opportunity for supplementing their basic pay by putting in an extra effort. Usually, however, the maintenance worker is outside this group, and often he feels it keenly. The difficulties of applying any form of bonus scheme to the usual run of maintenance work are, of course, many, with that of obtaining a basis of comparison for so non-repetitive a job outstanding; but in spite of this, it is difficult to avoid the feeling that the matter is too easily dismissed by many managements. That schemes are being worked in this country is well known, and in an article in our "Industrial Maintenance" section, an authority on this subject claims that they are a success, and outlines the principles they incorporate. When consideration is given to such claims, however, it always proves difficult to separate the improvement obtained from the increased earning opportunities offered by a bonus scheme from that traceable to the systematic work study necessarily involved in setting up such a scheme, a study usually absent from the management of a maintenance department. In this respect it is of interest to recall that the Productivity team which went to the United States to study plant maintenance methods found work study in use, but little evidence of the application of incentive schemes exclusively to maintenance workmen.

## SMALL FIRM EFFICIENCY

Traditionally, the strength of British industry lies in the small and medium sized firms. This may not be quite so true today but unquestionably the bulk of manufacturing capacity in the country still remains in smaller units. The question then arises, can the modern techniques of management which have been found so valuable in large organisations prove equally applicable to small firms. To a considerable extent the closer contact between management and the workshop avoids the need for some of the elaborate methods of large scale plants but none the less there is much that can be learnt from current techniques and it was undoubtedly with this in mind that the British Institute of Management recently arranged a special weekend conference for the smaller firms. Such familiar subjects as work study and standardised costing amply illustrated this point with actual case studies, while in addition such factors as export markets and problems of growth, which bring such special difficulties to the smaller firm, also formed part of the syllabus. It was made quite clear that the technique of management is not a subject exclusively for the large firm.

## ILL-WIND IN AUSTRALIA

Day to day happenings in Australia receive considerable attention in Britain today, and when large areas of Queensland were flooded a few weeks back following heavy rains and wind storms, the story was extensively reported in our daily press. Amidst the moving tales of evacuated homes and drowned cattle, however, there was in progress an example of engineering opportunism that will take a deal of beating for presence of mind. It concerns the Capricornia Regional Electricity Board which operates in the Rockhampton area, in the centre of the flood-troubled zone. The Board has an extensive distribution scheme on hand, and the flood conditions provided an opportunity that might not—indeed, one hopes will not—become available for many years. Forthwith an aerial survey was organised of the flood-free areas of the 32,000 square miles of territory concerned, in search of the best and safest sites for the future substations. No doubt the answer will be in general what could have been obtained by a careful survey, but this snatching of an advantage from the unwelcome excesses of wind and weather has secured convincing evidence of good sites at lower cost.

# Earthing in Practice

## PART III*—APPARATUS AND INSTALLATION IN FACTORIES

By F. H. MANN, M.I.E.E., *H.M. Senior Electrical Inspector of Factories and Electrical Adviser to the Home Office*

WHAT could be simpler than earthing? Why has so much been written and talked about the subject, when with a little assistance from the I.E.E. Regulations we can connect the metalwork of an installation to a water pipe, or the next best available "earth," and there we are!

Well, let us see.

The definition of "earthed", in the Electricity (Factories Act) Special Regulations, 1908 and 1944 is, "Connected to the general mass of earth in such manner as will ensure at all times an immediate discharge of electrical energy without 'danger' "; while the Electricity Supply Regulations, 1937, say that "connected with earth" means "Connected with the general mass of earth in such manner as will ensure at all times an immediate and safe discharge of energy." The difference between these definitions is hardly significant, and in each case it is assumed that unwanted energy has somehow appeared and must be dissipated by this process of "earthing". At this point it should perhaps be made clear that the specialised subject of earthing for the dissipation of static electricity is not specifically dealt with in what follows.

Both definitions quoted above refer to "energy" as the unwanted thing which must be discharged or expelled, and this implies that it has found its way out of its legitimate path in the circuit on to some external metalwork, which has in the process been turned into an exposed conductor, with consequent danger to life, or risk of fire. Since this "energy" must originate in the supply, we must take steps to ensure that its return path is as direct and unimpeded as possible.

Earthing in most practical applications is only a means to an end. It has sometimes been regarded as an end in itself, often with unfortunate consequences, as the tally of accidents due to ineffectual earthing measures abundantly demonstrates. The object, as mentioned above, is to provide a path back to the earthed point in the windings of the supply generator or transformer of sufficiently low impedance to permit the protective gear to operate and thus by cutting off the supply, to enable the energy to "discharge" safely to earth.

We could well leave the matter there, for the fundamentals are mainly contained in that statement; but certain considerations of a practical nature arise which may repay a little further attention.

### *Earth-fault Current Paths*

The conventional a.c. supply in this country is afforded from a system with the neutral earthed, and on the efficacy of the connection of the casings or framework of consumers' apparatus to this point will depend whether our earthing fulfils its purpose.

The return path can be provided by the "mass of earth" or by a metallic conductor. Recourse to the first method is often unavoidable where a consumer is supplied from a network and thus has no direct access to the neutral of the transformer. In such cases he must, as a rule, rely on some contact with earth both on his own premises and at the substation. In urban conditions the earthing of the neutral electrode is often augmented by the effect of a network of cable sheaths to which it is connected, thus reducing the overall resistance. In rural areas, on the other hand, where overhead lines provide the supply, this factor is absent, and the situation is not infrequently aggravated by high soil resistivity.

In either case the factory occupier must face the necessity of providing a contact with the mass of earth, and, since earthing is a relative term, he must make certain by tests that the resistance of the return path to the neutral at the supply point is low enough to ensure the operation of the protective gear. The whole of the circuit traversed by the fault current is somewhat extensive, and the factors limiting the current are represented by the algebraic sum of the several resistances or impedances limiting the current between the fault and the earthed point of the supply apparatus. It includes the resistance or impedance of the series of conductors between the supply apparatus and the fault, the earth continuity conductor, earthing lead, the earth electrode associated with the installation and the

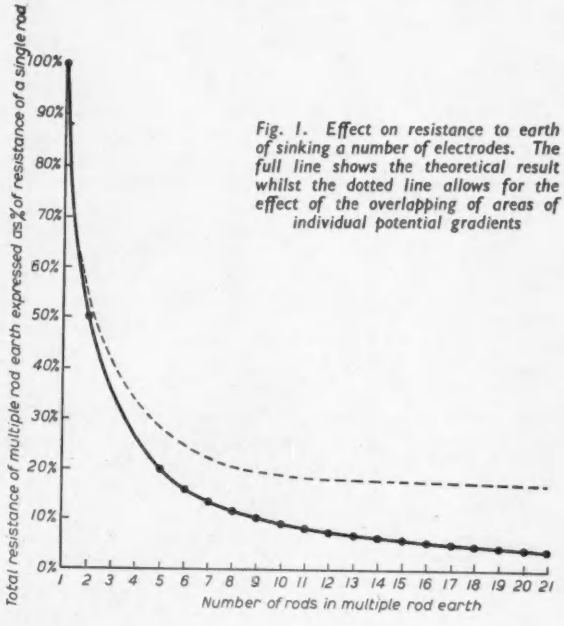



*Fig. 1. Effect on resistance to earth of sinking a number of electrodes. The full line shows the theoretical result whilst the dotted line allows for the effect of the overlapping of areas of individual potential gradients*

* *Parts 1 and 2 of this series which were contributed by Mr R. W. Ryder were published in the* ELECTRICAL TIMES *on 7th and 14th January respectively.*

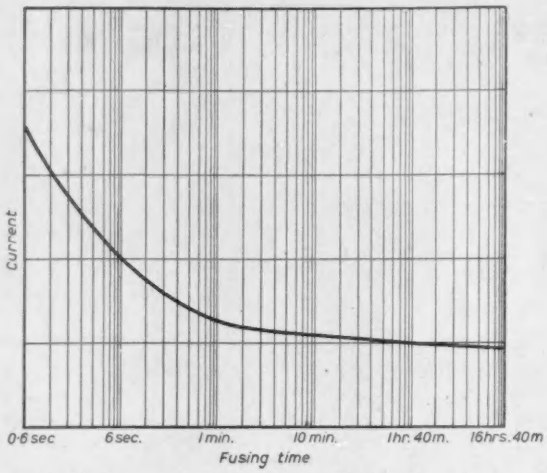



*Fig. 2. Fusing current/time characteristic for an h.r.c. fuse*

supply system respectively, and the impedance of the fault.

In this chain the elements (neglecting fault or arc resistance) which are likely to be responsible for the major proportion of the total resistance are the two earth electrodes, and these elements may also be mainly responsible for any variation in the total resistance, although the possibility of resistance changes in the metallic path, due to corrosion, mechanical effects or electrolysis, cannot be ignored.

In certain areas great difficulty is experienced in obtaining a sufficiently low resistance by the use of earth electrodes. Mr Ryder, in his article on "Earthing in Practice" in the ELECTRICAL TIMES of 7 January has shown the effect of installing a number of electrodes of various resistance values and it may be of interest to illustrate by another diagram (see Fig. 1) based on data of a similar character, the effect of the "law of diminishing returns" applied to a multiplicity of electrodes where a sufficiently low resistance is not achieved by the sinking of a relatively small number. In reality, as a result of the overlapping of potential gradients set up by each rod, the curve is more likely to resemble that shown by a dotted line, which illustrates this proximity effect.

It is important, whatever type of electrode be used, to ascertain by tests that the resistance of the earth-fault-current-path is low enough for the protective gear to operate, and with a substantial margin, so as to allow for seasonal variations in the resistance of the earth electrode and other eventualities that may effect this function. This article is not concerned *per se*, with protective gear, but it may be emphasised in this connection that earthing conditions are often such that protective gear on heavy circuits *cannot* operate on earth fault, and no amount of optimism on the part of the engineers responsible for the installation can alter the fact.

## *The Time Element in Protective Gear*

It is not sufficient that the protective gear should just clear the fault. Marginal operation of this character means a time delay, which in the case of fuses may be a very serious factor. A typical high rupturing capacity fuse may take 10 minutes to blow at a fusing factor between 1·5 and 2, the casings of apparatus so "protected" remaining at something like phase-to-neutral voltage in the meantime. The curve shown in Fig. 2 represents an average time/current relationship for such fuses, from which the necessity for the passage of a current large enough to ensure rapid operation will be apparent.

## *The Arbitrary Ohm*

The duration of exposure to shock largely determines its consequences and thus the minimum operating time should be aimed at and no set of conditions accepted which will not pass the fault current necessary to secure such operation. The arbitrary one ohm, whose influence has prevailed for so long, has had much to answer for in the way of ineptly conceived earthing systems and it is time that this figure, which can have only a doubtful relevance for any 415/240 V installation dealing with a current exceeding about 100 amps, was decently interred with those electrodes which for so long have vainly aspired even to its modest value!

Where conditions are such that the requisite fault-current values cannot be attained, attention should be given to the possibility of completing the earth-fault-current-path either by means of a metal conductor, or by recourse to earth-leakage protection. With such protection a resistance something like 15 times greater than would suffice for satisfactory excess current operation can usually be tolerated. It must not be supposed, however, that earth leakage protection is an infallible panacea and cases have been recorded where even the additional sensitivity achieved by this means has been inadequate.

## *Earth Electrode Resistance Ratio*

At this point we may turn aside for a moment to examine some of the effects of the relative values of the resistance of the earth electrodes at the neutral point and consumers' installation respectively.

If the resistance of the electrode at the neutral point is high and that at the installation negligible, the voltage rise on the occurrence of a fault (ignoring voltage drop in the distribution system) will be concentrated at the former which, in a 3-phase system, will rise to $\sqrt{3}$ of line voltage, while the two phases not associated with the phase on which the fault has occurred will rise to line voltage above earth. No voltage rise will occur on the apparatus on which the fault has occurred. Conversely, if the neutral point resistance is negligible and that at the installation high, the voltage rise will be concentrated at the apparatus on which the fault has occurred, with consequent severe shock risk. From this it might be contended that so long as we ensure that the installation earth resistance is low relative to the neutral point resistance, the conditions for safety are largely satisfied; and in furtherance of this it might even be suggested that where the neutral resistance is within the consumers' control, a high ratio might with advantage be maintained by the introduction of artificial resistance at the neutral point. If this could be achieved sufficiently within the operational ability of the protective gear to ensure rapid operation little objection could be raised, since in addition to a lower voltage rise on the apparatus the restricted fault current would tend to prevent disruptive effects. It should be borne in mind, however, that a concentration of voltage over the neutral resistance may well prevent the operation, at the consumer's end, of earth leakage protective gear relying on a minimum voltage rise.

In practice it is usually all too difficult to secure combined earth electrode resistance values low enough to allow excess-current protective gear to operate reliably; and even if the shock risk from apparatus, under conditions where the neutral earth resistance is relatively high, is reduced, the risk may only be transferred to the neutral point, where

a steep potential gradient within the ground will probably appear. Added to this, conditions approximating to inversion may arise at the installation, due to the voltage rise at the neutral point being transmitted by the neutral conductor, and a fatality has occurred from such a cause. The voltage distribution under varying conditions of neutral earth-continuity resistance is indicated in Fig. 3.

## *The Water Pipe Earth*

Since the days when 110 volts was a normal distribution voltage and d.c. the usual system of supply, the water pipe has been relied on for earthing, and where the earth connection was made by an uninterrupted system of underground pipework, no more effective earth could be found. In recent years, however, the use of non-metallic pipes has increased, with the result that the reliability of the water pipe as an earth electrode has declined. It is still difficult to match the low resistance qualities of the metallic water pipe, but it is necessary to ensure by preliminary and periodic tests that its efficiency remains unimpaired.

In the utilisation of a water pipe for earthing purposes it is, of course, necessary to ensure that the capacity of the pipe and connections are adequate to carry the maximum fault current possible from the installation, and where water meters are installed they should be bonded across.

## *The Earth-return Conductor*

With a view to overcoming the difficulties in areas of high ground resistance of effecting a return path to the neutral point of adequately low resistance the Electricity Commissioners* in 1947 issued a circular to all supply undertakings setting out the terms under which facilities for the earthing of consumers' installations on to the supply undertakings' own earth-return system could be granted. The methods permitted are as follows:

(*a*) by a direct connection where the undertakers' transformer is on the consumers' premises, such connection having a cross sectional area of not less than ·0225 sq in.

(*b*) by an additional conductor, having a cross sectional area of not less than ·0225 sq in. where the supply is by overhead line;

(*c*) by a connection to the lead sheath of the low or medium voltage cable, where the supply system is underground.

It is suggested in this circular that the consumer should be asked to take responsibility for the use of any such connection.

## *Substation on Consumer's Site*

We have hitherto been mainly concerned with the position where the neutral point of an earthed distribution system was not directly accessible to the consumer. The problem of securing a fault current return path of low resistance is simplified where the generating station or substation is situated upon the premises or within the site. In such cases a metal-cased system usually provides a sufficiently low resistance path; and where overhead distribution is used earth-continuity conductors to which the metal cases of apparatus are bonded can serve as well.

In these circumstances the circuit under fault conditions is from the source of e.m.f., viz, the windings of the generator or transformer, through the distribution conductors, and any windings in the apparatus that may be involved, through the fault to the enclosing metalwork, and thence to the conduit, ducting, cable sheathing or armouring, or overhead conductor, to the neutral point; and the existence of an earth electrode is irrelevant except as a means of stabilising the system against any tendency to inversion induced by a severe phase-to-earth fault, or against the whole system being raised above earth potential, e.g., by induction from another nearby system.

## *The Impedance Factor*

In most cases the earth return path will be substantially resistive in character, but with a.c. there is an inductive effect, and where steel conduit is used for the protection of the conductors this may be sufficiently pronounced to warrant consideration in estimating the impedance of the earth-return-path. This factor, while unlikely to be predominant in any installation of normal proportions, is worth attention where the length of conduit carrying single-phase main cables is considerable.

Research work on this subject has shown that the impedance can amount to from three to five times the d.c. resistance, while this can be considerably exceeded where the conduit and its conductors form part of a loop. It has also emerged that within the practical range of conduit installations the impedance is at a maximum from 20 to 30 amp, corresponding to the optimum permeability of the steel, declining thereafter as saturation increases. This fact lends importance to the assessment of impedance where values of this order happen to correspond with the fusing current associated with a given fuse rating. It will be seen that the commonly occurring fuse ratings of 10 to 15 amp will be thus affected.

The presence of steel armouring on a cable will also affect the impedance of the earth-fault-current-path, regarded as an earth continuity conductor, but no work appears to have been carried out on this possibility.

Reference has already been made to the function of the transformer neutral earth as a means of stabilising the system against any tendency to inversion, and it is implicit

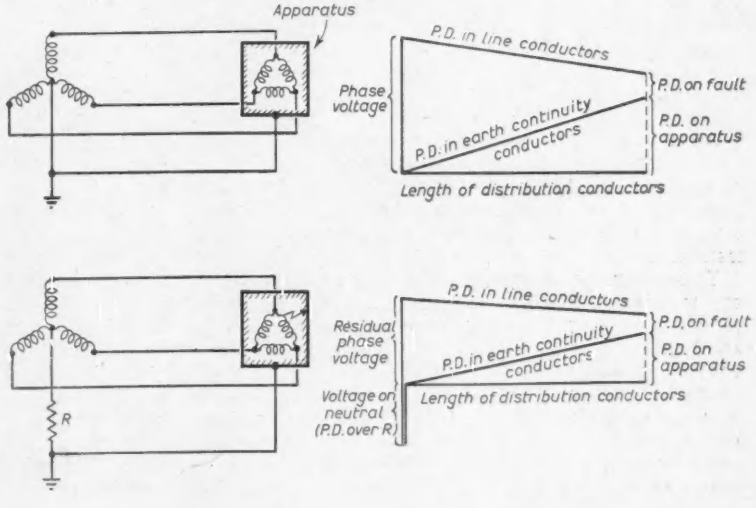



*Fig. 3. Voltage distribution under varying conditions of neutral earth-continuity resistance with a fault from one end of a winding to apparatus frame*

* *Now superseded in function by the Electricity Division, Ministry of Fuel and Power.*

in the analysis which precedes this, that the stiffness and symmetry of the voltage distribution will depend on the soundness of the earth. There are circumstances, however, where even a good earth may not be proof against the influence of a high-voltage primary breakdown, and this can occur where the non-current-carrying metalwork of the high-voltage side and the secondary neutral share a common earth electrode. Instances are on record where under such conditions the potential of the medium-voltage system has been raised to several times its normal value, followed by outbreaks of fire, and it is generally recommended that where practicable the respective electrodes should be separated as widely as possible.

It is perhaps fortunate that compliance with this usually presents no great difficulty where the transmission is by overhead lines in rural areas, since it is under such conditions that high-resistance earths are more usually found. In urban areas the prevalence of intimately-bonded metal-cased systems on both primary and secondary distribution may render separation virtually impossible—although compensation is usually provided in the lower collective earth resistance which that very fact ensures.

## *Persistent Earth Leakage*

Some few years ago one department of an extensive factory was largely destroyed by fire. The cause was traced to local heating in a length of conduit due to an internal cable breakdown to the conduit, which was melted over a length of about 2 ft 6 in. The fuses did not blow: thus the fault had remained uncleared. Subsequent examination indicated that the arc had gradually risen from the original point of the fault, cutting a neat slot in the vertical tube as the molten copper dripped away.

The fault occurred on a lighting sub-circuit, which had been branched from a main circuit protected by 200 amp fuses, and such fuses would be capable of carrying about 350 amps for a long period without melting. Tests carried out on what was left of the conduit installation showed a loop resistance of 0·24 ohms, a very satisfactory figure; and thus there must have existed a relatively but perhaps not excessively high resistance element in the sub-circuit conduit to prevent the passage of sufficient current to blow the fuses reasonably quickly. If on the other hand the sub-circuit had been fused in accordance with its rating there is a fair probability that the fault would have been cleared. The damage to the conduit and junction box involved in this occurrence is illustrated in Fig. 4.

More recently a fire was caused by the scattering of hot particles from a perforation in a length of 1¼ in. heavy-gauge conduit caused by an internal breakdown of the v.r.i. cable. It was assumed that at the point where the fault occurred the cable had been damaged when being drawn in, further deterioration occurring from the effect of damp, traces of which remained elsewhere. The length of screwed conduit on which the breakdown occurred was connected to further lengths of lug-grip tube, and the resistance of the earth-continuity-path was too high to permit the 100 amp fuses to blow. It was ascertained that earth-continuity tests had been performed with an insulation-measuring instrument!

These examples are mentioned as evidence of the necessity to relate the current value necessary to operate the protective gear with the resistance (or preferably impedance) of the earth-fault-current-path between the earthed point of the supply and the extremities of the installation.

Since conduit is the most commonly used method of cable protection in factories, it is worth while examining the causes of the bad continuity which tests so often disclose. Assuming that the tube is not eroded to such an extent as seriously to affect its cross-sectional area, bad continuity is caused by the incidence of high-resistance joints. In some cases where the continuity resistance may originally have been satisfactory the subsequent development of high resistance joints can be sufficient to upset this, with possibly calamitous consequences. Tests, confirmed by experience, have shown that joints not fully tightened will show, after erection, and under some stress, a low value of resistance which, however, in course of time will deteriorate. Resistance measurements taken soon after erection are thus not necessarily criteria of the soundness of the installation, which means that a great deal of reliance must be placed on conscientious workmanship. In practical terms, good continuity and its continuance depend on the "last half turn" being given, and there are circumstances as every wireman well knows, where this final forcible tightening may be difficult. The remedy in such cases is the lock nut, and where, from the configuration of the run, it is clear that the last half turn at some joint cannot have been given, the absence of a lock nut at that point should be strongly suspect. A method of testing conduit is described later in this article.

In cases where it is necessary for the apparatus to be given some freedom of movement, either to accommodate adjustment or to allow for the possible effects of vibration, recourse is often had to a flexible metallic tube as a protection for the cables, and in such instances an auxiliary earth-continuity conductor of a flexible character should be installed as a safeguard against fracture of the metallic tube or slackness in its connections.

Corrosion undoubtedly tends to increase the resistance of joints which have not been completely tightened. The use of a protective compound at the joints, such as petroleum jelly, graphite grease or atomised lead is to be recommended as a safeguard against the effect of various adverse influences during the life of the installation.

In the case of installations where the fault-current-return-path is provided by metal-sheathed or sheathed and armoured cables, precautions against the incidence of high resistance contacts at the junctions between the sheathing or armouring and the apparatus to which it may be connected must be taken by careful workmanship and any incipient resistance detected by periodical tests. A technique similar to that adopted for conduit testing, described later, may be used, joints in sheathed or armoured cable having been found to be equally susceptible to that method.

It should be noted in the case of long runs of lead-sheathed cables, that the resistance of the return path represented by the sheath should be carefully checked against the minimum requirements of the protective gear setting, and this applies particularly where the cable supplies a single unit of apparatus, in contrast with an arrangement where sub-division enables lower settings to be adopted. In some cases the resistance of the lead sheathing may be too high for the purpose without recourse to a parallel earth-continuity conductor, which for convenience and mechanical protective purposes, may well take the form of armouring. It is interesting to note that in a typical case the resistance of the lead sheath is about two and a half to three times that of single wire armouring.

## *Bare Neutral Returns*

In recent years cables insulated with mineral compound and encased in metal have found increasing popularity, and in some applications the outer sheath, usually of copper, has been utilised as the neutral conductor. In these circumstances the occurrence of a break in the sheath would be serious, since beyond the points of the break it would become live when any load was connected. This method of distribution is hardly to be recommended, and it should only be adopted where the neutral can be multiply-earthed, or at least a reliable earth connection

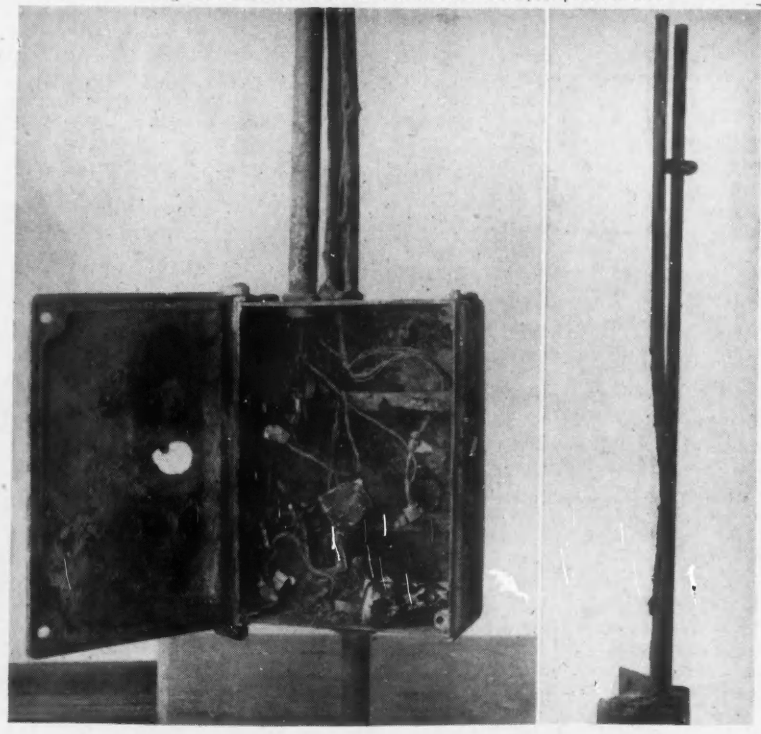
made at the termination of each circuit. The necessity for this precaution necessarily precludes the use of the scheme in installations connected to a public supply system, since the supply regulations prohibit in general the earthing of the neutral at more than one point.

Earth leakage protection, depending on balanced current in lead and return, may be difficult to apply to multiply-earthed neutral systems since the value of current returning along paths extraneous to the neutral may be equal to, or exceed the operating current of the trip. Reliance on graded fusing for discriminative protection might also be affected since a small additional earth leakage current, insufficient to blow the lightest sub-circuit fuse, might cause the earth leakage circuit-breaker, controlling perhaps a main circuit, to operate.

## *D.C. Installations*

While a.c. systems largely preponderate, there remain a number of d.c. installations where the necessarily high settings of protective gear associated with supplies to single large units, and the possible existence of appreciable resistance in the mid-wire connection to earth raise an acute problem in circuit protection. Examples of this are to be found mainly in the steel and other heavy industries. The difficulty has hitherto centred on the intractability of d.c. in lending itself to earth-leakage operation, but recently attempts have been made to apply the principle of the saturable reactor. This apparatus is equipped with a core in which the degree of saturation from the effect of any current unbalance between the main conductors of the circuit controls an alternating current from an auxiliary source, which is arranged at some predetermined value to trip the circuit-breaker. It will be evident, however, that in its application to the outer conductors of a 3-wire system, or indeed to any pair of conductors one of which is not earthed, the effect can be vitiated by a simultaneous leakage of similar magnitude from each pole.

*Fig. 4. A cable fault, in one of the conduits seen here, caused a serious factory fire. Arcing cut the slot shown in the conduit but a main fuse failed to blow*



## *Insulated A.C. System*

Hitherto the function of earthing and protective gear has been considered mainly in relation to the predominating earthed supply systems. There is, however, a diminishing number of insulated systems in use both in public and private supply, and a brief note on the conditions associated with such systems may be appropriate. So long as the insulation of such a system remains sound the shock sustained from contact with a phase conductor is in general fraught with less danger than in the case of an earthed system, since the current will be restricted to that due to distributed capacity, which will be proportional to the extent of the system and the specific inductive capacity of the insulating materials used. In an extensive system this element of capacity current cannot be ignored, as a fatal accident has proved. It is therefore essential that the non-current-carrying parts of all apparatus should be earthed, although higher values of fault resistance than those required for earthed systems will, as a rule, be sufficient to extinguish the voltage, since, unless another part of the system is accidentally earthed, this will not depend on the operation of protective gear.

A glance at the conditions which can arise when contact with an insulated system is made may not be out of place in this connection. So long as the system has fairly high resistance to earth, an earth at the apparatus of comparable value will appreciably reduce the voltage, while a low resistance earth, in terms of the order of values aimed at in earthed systems, will extinguish it; in other words the higher the system earth resistance the higher the earth resistance that can be tolerated at the apparatus without producing dangerous conditions. As the system earth resistance declines so, to ensure safety, must the apparatus earth resistance be decreased, until a point is reached where a "dead" earth in the generator and transformer windings, or on another phase, demands correspondingly low values of apparatus earthing. It will be appreciated, however, that when dealing with resistance values of a magnitude which can pass more than, say, 20 mA, a ratio between "system" earth fault resistance and apparatus earth fault resistance slightly unfavourably to the latter could produce serious shock conditions. At such levels ordinary protective gear will not operate, and safety will depend upon earthing. Since, however, lower values of "double fault" resistance may develop, the resistance values aimed at in the earthing of apparatus should be no higher than those appropriate for similar circuit conditions in an earthed system, while the protective gear should be set with as much regard to its effective operation. It is often supposed that earth leakage protection is of no avail, but it will, I think, be clear from this survey that current-balance protection can be effective under the most dangerous conditions, i.e. those arising where a double fault (i.e. on system and apparatus respectively) has occurred, limited only by the somewhat remote possibility of simultaneous, and approximately equal, leakage from the two or three conductors of the protected circuit. It may be thought from a study of these considerations that the earthed system in which the relative potentials are established

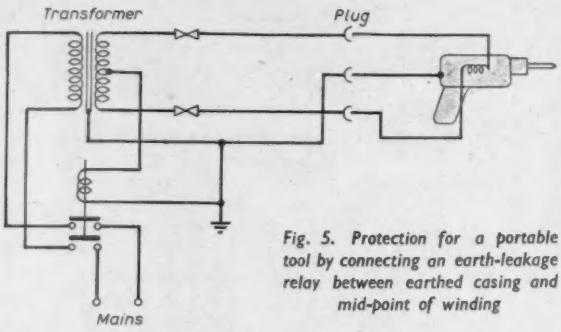



*Fig. 5. Protection for a portable tool by connecting an earth-leakage relay between earthed casing and mid-point of winding*

and unlikely to be substantially affected by accidental earths, has a balance of advantage. There may, however, be circumstances where an insulated system is safer, and an instance of this is afforded where a supply is taken from a mobile generator, as on building sites.

Under the conditions in which such plant is used, and with earthing, in all probability, depending on a driven spike of dubious conductivity, a "system" earth is more likely to introduce than to avert danger, since it establishes a shock-current-path back to the windings from any fault on the portable apparatus supplied by the generator. An indifferent "earth" may pass a lethal current without enabling the protective gear to operate. It thus seems to be better practice to abstain from earthing the generator winding (i.e. the "system") and to rely on a bond between generator frame and the frames of the portable apparatus supplied, so as to equalise any difference of potential appearing between these units as a result of a fault. In addition, the best earth connection that it is possible to secure should be made to the frames since, in the event of any system leakage, as might be caused for example by an internal fault in the generator and leakage to earth over the wheels of the vehicle, an earth connection to the frame of the portable apparatus, even of fairly high resistance, will tend, in the event of the bond between generator frame and portable apparatus having been severed, to reduce the voltage between the latter and earth.

As in many other applications the best technical solution of the problem entails a little additional complexity and somewhat higher cost, and in this case it is undoubtedly represented by recourse to an earth-leakage relay connected between the neutral or mid-point of the generator winding, and the tool casing. This device, while providing a sensitive means of protection, would be independent in its operation of the resistance value of the earth provided for the tool. The apparatus is illustrated in Fig. 5.

## *Portable Apparatus*

Earthing is perhaps of greatest consequence in its application to the use of portable apparatus. There is a tendency in some quarters to deprecate direct earthing as a safeguard, on the ground that double insulation or certain forms of protection are to be preferred, and attention is sometimes drawn to the accidents caused by the *presence* of the earth conductor.

Now we know that the use of portable apparatus at mains voltage accounts, year in and year out, for some 30% to 40% of the total electrical fatalities in factories. In 1952 the presence of the earth core (becoming detached and contacting the phase terminal in the plug) accounted for ten accidents (two deaths), and in 1953 for fifteen accidents (one death), a circumstance for which inept maintenance work and inefficient cord grips were about equally to blame. We do not, however, know, of the tens of thousands of persons at risk in the use of such apparatus, how many lives were *saved* by its presence, but it would be a fair assumption to say that in a good proportion of portable tools developing electrical defects a lethal voltage would have appeared on the frame but for the earth conductor.

Safety in the use of portable apparatus is best secured by recourse to a voltage substantially less than that of the mains, and if a value is selected such that the shock risk to earth does not exceed about 25 volts it is in some cases possible to dispense with the earth connection. This article is, however, concerned with earthing, and its application to portable apparatus must therefore be considered in its function as a protective measure. Various types of protective gear suitable for portable apparatus are available, but it should be borne in mind that earthing is required under Statutory Regulations. Of the methods of protection, the type in which the mid-point of the secondary winding of an isolating transformer is connected through the operating coil of the earth leakage trip to the casing of the apparatus offers perhaps the most sensitive protection, and its function is unimpaired if the earth connection should be severed. An application of the apparatus is illustrated in Fig. 5.

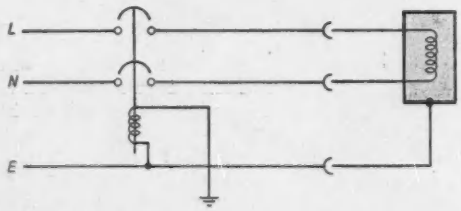



*Fig. 6. Voltage-operated earth-leakage circuit-breaker with direct acting coil. It is shown provided with direct and auxiliary earthing connections*

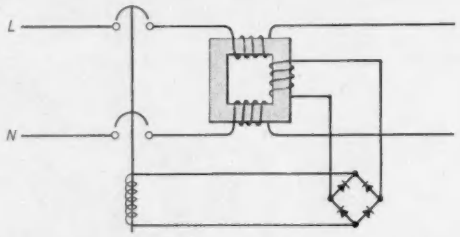



*Fig. 7. Differential-current earth-leakage circuit-breaker*

## *Earth-leakage Protection*

The so-called "voltage-operated" earth-leakage circuit-breaker offers an alternative means of protection. Its application, however, in some circumstances offers difficulties, since a separate earth electrode, removed from the influence of the direct earth, is required. It is sometimes thought that the separation of the auxiliary earth electrode is an unnecessary refinement, and that the trip should be relied upon to operate in the event of a defective "direct" earth permitting a sufficient voltage to appear on the apparatus. It is in just such circumstances that failure to clear the circuit may occur, since the parallel "direct" earth may be of such resistance as to prevent the overcurrent protective gear from working while having the effect of short-circuiting the high impedance operating coil. The connections for a voltage-operated earth-leakage circuit-breaker are shown in Fig. 6.

A useful application of the voltage-operated earth-leakage circuit-breaker can sometimes be found where the

conditions are complicated by the presence of d.c. circuits, as may occur for example in the case of electrolytic plating baths arranged in series, and supplied individually through resistances from a d.c. supply and heated by an a.c. immersion heater. The presence of the a.c. connections renders precautions necessary to prevent the tanks from becoming live, but a solid earth would be liable to set up undesirable d.c. circulating currents. In the case of fixed equipment the Regulations give us the option of adopting means other than a permanent earth to avoid danger and thus offer a wider choice of method than is possible where portable apparatus is concerned.

An acceptable method here is to earth the body of the bath through the operating coil of an earth-leakage circuit-breaker arranged to trip the supply to the heater in the event of a fault developing. The d.c. circuit in the bath is isolated by interposing a capacitor in series with the coil of such capacity that it will pass the requisite tripping current without introducing resonance. In practice there is no difficulty in reconciling these requirements. As an alternative, potential relays, similarly arranged, have been used successfully.

## *Balanced Current Protection*

A form of protection which has perhaps a wider application than any other type is that depending on unbalance between the current in the respective conductors forming the circuit. It is the more surprising that until recently the use of such protection has been almost exclusively confined to heavy-current circuits.

In the form developed for comparatively low current circuits the output from a core-balance transformer is rectified and connected to a relay which actuates the trip mechanism, as shown in Fig. 7.

Such protection, if arranged for operation on a low differential current, provides an excellent safeguard against the effects of earth leakage current, and by its nature it is appropriate for *circuit* protection as compared to the voltage-operated trip which is primarily designed for responding to current leakage affecting metal enclosures. For this reason it can be applied to protect against leakage to earth from non-metal cased wiring systems, and it thus forms an assurance against the fire risk arising from persistent earth leakage of a value too low to operate the over-current protection. Its ability to operate independently of the voltage factor distinguishes balanced-current protection from the "voltage-operated" type, and this advantage will be realised under two sets of conditions (*a*) where the distribution of voltage between the substation neutral and the fault on the consumers' apparatus are such, due to relatively high resistance at the former, that the voltage on the apparatus is below the operating point. In these circumstances the shock risk from the apparatus might be negligible, but the neutral will have assumed a potential approaching phase voltage and the effect of this, transmitted back from the substation may, as has already been described, be dangerous. (*b*) The earth fault may be at such a point in the windings of an item of apparatus that the voltage available will not operate a voltage-operated trip, while the excess current is insufficient to blow the fuses. In these circumstances a severe fire risk can arise.

Balanced-current earth-leakage circuit-breakers suitable for line currents of about 30 amps have been developed to operate at a differential current low enough to provide at once adequate protection against the fire risk arising from concentrated and persistent leakage and a safeguard against the shock risk at relatively high values of earth resistance. It is interesting to note, in the application of this form of protection to portable apparatus, that if it were possible to effect rapid operation by contact with the person, with a differential current substantially below the lethal level the absence of an earth connection would be of less significance. A development of this kind may not be such a far cry, since no difficulty is now presented by a differential of 150/200 milliamps, while a current less than 50 milliamps is unlikely to be fatal if the shock is not sustained.

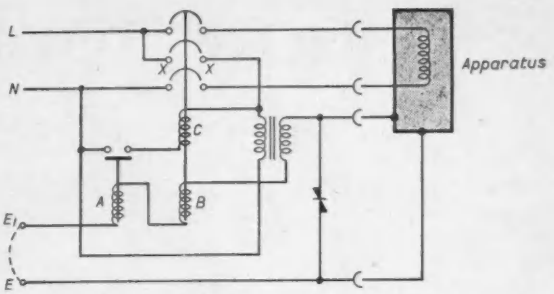



*Fig. 8. Circulating-current protection embodying trip coil responsive to fault current and non-linear resistance*

On closing the circuit-breaker by hand the auxiliary contacts XX make before the main contacts and connect both the transformer and voltage-operated trip coil C in circuit. Relay A is supplied from the transformer and is timed to open its contacts before coil C can trip the breaker when the closing movement is completed.

If the earth-continuity circuit is interrupted relay A will close by spring action and the breaker will be tripped by the circuit completed through coil C. To counteract the effects of a fault developing on the portable apparatus such as might produce a current so much in excess of the normal "hold-on" current as would tend to hold in relay A, another coil, B, is provided to trip the breaker in response to this current. The functions of coils A and B are therefore differential. A heavy fault, however, may cause a serious voltage rise before the trip can operate and a non-linear resistance is sometimes introduced to shunt the three coils to earth under fault conditions.

The function of coil B can alternatively be performed by an earth-leakage relay connected between the mid-point of the secondary windings of an isolating transformer and the main limb of the earth circuit.

## *Circulating Current Protection*

The efforts expended on the development of protective appliances for portable apparatus have for the most part been stimulated by a realisation of the risk of a considerable potential attending the failure of continuity of the earth conductor. An attractive method, however, lies in making the connection of the apparatus to the supply dependent on such continuity, and this takes shape in the form of "circulating-current" protection in which a small contactor is held in by a low-voltage current circulating through duplicated earth leads (conveniently effected in the case of single-phase apparatus by a 4-core flexible cable or by a metal-screened 3-core cable). A break in the continuity system will isolate the apparatus irrespective of any fault. Such protection, incorporating various necessary refinements, has reached a high state of reliability, and it can be extended in application to monitor, within limits, the actual value of the earth resistance to which it is connected. Circulating-current protection is sometimes combined with a sensitive earth-leakage device. A typical arrangement is illustrated in Fig. 8.

Among other matters associated with the subject of earthing are a number which can best be considered under separate headings, and these, together with methods of testing, will be considered in Part 4 of this series.

*(To be concluded)*

# HOW TO USE VALVES

## *Code of Practice Suggests Application Principles*

GUIDANCE for designers of equipment using electronic valves is set out in the latest British Standard Code of Practice, C.P.1005, which was published last week.* At present only the first two parts of the Code are available; general recommendations and receiving valves, c.r. tubes and rectifiers. Further parts giving recommendations for other types of valve are now being prepared, and will be published in due course. The Code has been prepared by a committee set up jointly by the B.S.I. and the I.E.E., and the recommendations it contains are based on original material provided by the British Valve Manufacturers' Association.

In the general section initial emphasis is on the need to study published data before equipment design is commenced, and to maintain close liaison with the manufacturer. Where a new valve type is involved, it should be borne in mind that there may be considerable variations in characteristics and dimensions, between first samples and subsequent production.

Ratings of valves may be expressed by either of two methods. The "absolute" system gives definite minimum values for the conditions specified: if these limits are not observed, the life and performance of the valve may be impaired. On the "design centre" system, on the other hand, the stated ratings give a factor of safety to allow for normally encountered voltage variations.

### *Mounting and Cooling*

Normally valves should be mounted base downwards and in a vertical position. When it is necessary to mount valves horizontally the plane of the filament of directly heated valves should be vertical. Valves should either be so positioned that they are not affected by strong magnetic or electric fields present in equipment, or else they should be well shielded. As a general guide, the ventilation of the valve should be so arranged that the hottest part of the valve under operating conditions is not more than 20°C hotter than it would be if the valve were operated at its maximum rating under conditions of free air circulation in a room temperature of 20°C. In considering valve temperatures it has to be remembered that the proportion of heat dissipated from a valve by radiation is about one-half.

On the subject of storage, it is suggested that valves not installed in equipment should be stored in their original packing or in suitable racks. Normal storage conditions should be provided to prevent deterioration, such as corrosion of contacts or impairment of electrical insulation.

One section of Part 2 of the code gives additional recommendation for rectifiers, including grid-controlled rectifiers, that is, thyratrons, and this is likely to be of some importance to engineers concerned with industrial equipment. Rating is first dealt with, and it is emphasised that in assessing the peak inverse anode voltage at which a rectifier operates, due allowance must be made for the presence of transients. Adequate precautions must be taken to ensure that the peak anode current does not exceed the manufacturers' rated value, in general by the introduction of a limiting resistance into the circuit.

Ventilation sometimes requires special consideration. Although it may in certain cases appear desirable to employ screening cans to reduce radiation of hum or interference, rectifier valves are not normally designed for such use, and there is generally a danger of an undesirably high bulb temperature. It has to be remembered, on the other hand, that since the mercury vapour pressure within this type of rectifier is a function of the temperature at the coldest spot, care should be taken in directing any cooling air stream, to avoid lowering the temperature too much.

Where two or more half-wave rectifiers, or both halves of a double rectifier are used in parallel, a separate limiting or stabilising device, such as a resistor or reactor, should be connected in each anode lead. Without such a precaution the rectifier having the lowest voltage drop will carry the heaviest current, and will fail if overloaded.

Additional recommendations applying exclusively to thyratrons include the provision of a series grid resistance, and attention to the fact that when automatic bias is applied the sum of the bias voltage developed and the peak value of heater to cathode voltage must not exceed the maximum specified heater to cathode voltage.

* *Price 6s. from B.S.I., 2 Park Lane, London, W.1.*

## *WORLD PLANS FOR ALUMINIUM*

ALUMINIUM and steel are in competition over a wide range of applications, but from the viewpoint of total consumption, competition is on a relatively small scale and will remain so. This is the conclusion reached by the Secretariat of the United Nations Economic Commission for Europe, and set down in a report published this week. In the course of this report, there are some interesting figures on plans for aluminium production.

In 1939, 54% of the production of aluminium was carried on in Europe, but by 1953 this proportion had dropped to 18%, and in the future it is likely to continue to fall as production tends to move nearer sources of cheap electric power. Major increases in capacity are planned for the United States, including the possibility of a 200,000 ton/year plant in Alaska. In Canada, the Kitimat project should double production by 1960. At this plant on the Pacific coast of British Columbia, alumina from Jamaica will be processed with the aid of a large hydro-electric station. Production should start in the coming summer.

The Volta River scheme for the Gold Coast is still under discussion, but if it is undertaken it should provide 80,000 tons/year by 1962. There is also some possibility of a 100,000 ton/year plant in French Guinea, and a 40,000 ton/year plant in the Cameroons, both hydro-electric based.

In Norway, where water-based power is still plentiful, a 45,000 ton/year plant is nearing completion. Norway follows Canada in the world list of exporters. Yugoslavia plans a 50,000 ton/year production. It has large-scale bauxite deposits but water power development is lagging. Hungary is producing aluminium by the use of steam power plants burning lignite.

Russia has a big expansion programme on hand, totalling some 335,000 tons/year, and from available information it appears that the centre of production there is moving east of the Urals. India is considering expansion in terms of a 10,000 ton smelter near the Hirakud River project, while for Australia the Bell Bay works in Tasmania may be expanded to give 25,000 tons/year.

# READERS' VIEWS

*Correspondents writing under a pseudonym are asked to submit their names in confidence to the Editor*

## *Ring Circuits*

I WRITE to enquire what has happened to our friend "Megohm". Either he has completely lost his punch, or he is shadow boxing so cleverly that ordinary people like myself cannot follow him.

In his article in the current issue of the ELECTRICAL TIMES under the sub-heading "Switch-sockets" he refers to 13 amp sockets wired to form a "ring main". Now I'm quite sure that "Megohm" is fully aware of the difference between a "ring main" and a "ring circuit" as defined in section 2, Regulation 201 C of the I.E.E. Wiring Regulations, and this makes it the more puzzling that he should fall into the same error as less well informed persons. However, the point that seems to indicate that he is losing his grip, is his reference to unscrupulous contractors taking advantage of the architect's inexperience of "ring main" installations, and the results having shown no saving in cost.

The plain fact is that the "inexperience" of a great number of architects is apparent to everyone but themselves, and exactly the same criticism can be levelled at a good many electrical contractors. A surprisingly high proportion of both seem never to have heard of British Standards, Codes of Practice, Post War Building Studies, and other similar publications, produced to assist them in keeping abreast of progress.

At the same time it will be borne in mind that the ring circuit principle of wiring, using 13 ampere shuttered socket-outlets and fused plug tops was developed to make it possible to provide an adequate number of socket outlets at reasonable cost, rather than save money on the average electrical installation.

It seems to me that the electrical contracting industry as a whole should pursue a very much more vigorous development and publicity policy, and see to it that not only architects get the information and advice that is available, but that housing authorities generally, and individual members of housing committees in particular, should be fully informed, so that modern houses may be properly equipped with a modern electrical installation.

I suggest that one step in this direction might be for "Megohm" to compare the average number and type of socket outlets being installed on housing sites throughout the country with the recommendations of Building Studies No. 11 and let us have his comments on his findings.

*S. G. Christian,*
EWELL, SURREY.

## *TV and Lightning*

IN your correspondence column of Readers' Views, I read an interesting letter from Mr B. P. Meade, of Tolworth, which appeared in your issue of 18th February, in which he points out the potential danger from lightning striking television aerials.

I agree with Mr Meade that there is a danger in this and that precautions should be taken to protect not only the building which carries the TV aerial, but also the TV set itself.

There is such a device already on the market. This is the type LV Surge Diverter made by Metropolitan-Vickers. It comprises a Metrosil disc and spark gap, all contained in a polythene moulding from each end of which there is a flexible lead. The whole thing weighs not more than a few ounces and costs about £1. If this device is connected between aerial and earth, i.e. in parallel with the TV set, very adequate protection will be provided to both the building and the set. In the event of lightning striking the aerial, the voltage arising from this will operate the gap at a relatively low value and the discharge will be diverted through the Metrosil to earth. The non-linear feature of the Metrosil will enable conditions to be restored to normal as soon as the lightning discharge is completely diverted.

*W. H. Thompson,*
METROPOLITAN-VICKERS ELECTRICAL CO. LTD.,
MANCHESTER, 17.

## *Bell Transformer Rating*

WE were very interested to read in your section "Problems and Practice" the comments of Mr K. Coombs, of Cape Town, on the above subject, particularly as he was referring, in the first paragraph, to our "Warbler" Door Chime.

We are, however, at a loss to understand his problem on connecting up the Chime, as we have taken a lot of trouble to provide a very detailed instruction folder complete with simple diagram. We grant Mr Coombs his point that this is not attached to the article, and can be accidentally lost when the carton is opened.

From this instruction folder it can be seen that we recommend a transformer with an output of 4-8-12 volts at a specific rating of 8 VA. We have always rated our transformers with specific ratings, and made them so that they will deliver the stated output. We have found, however, that in many overseas markets where price is the first consideration, some bell transformers have inaccurate ratings. It is possible to get away with this in practice on most normal bell circuits, but chimes require power for satisfactory operation, and any lack of this is immediately apparent as Mr Coombs has found out.

*J. Doggart,*
V. AND E. FRIEDLAND LTD.,
MACCLESFIELD, CHESHIRE.

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## I.E.E. N.W. CENTRE DINNER

SOME 450 members and guests at the I.E.E. North-Western Centre Annual Dinner heard Sir Robert Burrows, K.B.E., J.P., propose the toast of the Institution. Sir Robert pointed out that at the present time there was a definite lack of advice on choice of careers being given to the younger generation. The electrical industry, he said, provided a great opportunity with its future growth. The President, Mr H. Bishop, referred to Manchester as not only a vast centre of industry but also of B.B.C. activities. The Institution itself was in a flourishing condition, but he deplored the falling off in graduates to the electrical industry. We were not expanding as far as training and education were concerned, and technical achievement was thus limited. The fundamental trouble lay in the lack of science teachers and here the I.E.E. was doing all it could to help. The maintenance of liaison between industry and education deserved the fullest support of the Institution's 38,000 members.

"Our Guests" was proposed by the Chairman, Mr H. West, who mentioned the work of Sir Robert Burrows in connection with "Remploy," and the response was made by Dr P. F. R. Venables, Principal of the Royal Technical College, Salford, who spoke of the co-operation he had received from the I.E.E. Developments now in hand were long overdue, and the support of the I.E.E. was more than welcome.

# *Voltage-Current Relationships in Rectifier Load Circuits*

## CURRENT CONTINUITY AS DECIDED BY CIRCUIT CONSTANTS AND THE EFFECT ON OUTPUT VOLTAGE—PART 2

By R. WELLS,* A.M.I.E.E.

THE output e.m.f. of a rectifier depends for its wave shape upon the number of secondary phases and the degree of anode firing delay. It is the object of this article to show some of the effects which circuit parameters may have upon the wave form of the e.m.f. and upon rectifier regulation. In part one of the article, typical results with a resistance load were considered, and a method was given for predetermining the regulation curve and load operating point in the absence of back e.m.f. Finally, the general effects of back e.m.f. were discussed. In the present part, inherently discontinuous conduction fails to be considered.

Where conduction is found to be inherently discontinuous (due to the back e.m.f. having a value higher than the instantaneous minimum of rectifier voltage) a number of new factors have to be taken into account. The rectifier voltage and the back e.m.f. are, of course, in opposition, but current flow can only take place in one direction i.e. from rectifier to load. The current value is then decided by the average positive excess of rectifier voltage over back e.m.f. (divided by resistance) and during those periods when the rectifier voltage is lower than the back e.m.f. there is no current flow in either direction.

This has such effects as enabling a battery of a certain voltage to be charged by a rectifier of lower average voltage and allowing a d.c. shunt motor to run above its correct no-load speed in spite of being supplied from a rectifier of the correct voltage. Again, even if the rectifier and the source of back e.m.f. are separated by a resistor in the circuit, the back e.m.f. will impress itself upon the rectifier terminals during the instant when it is higher than the rectifier voltage—there being no current and no volt drop across the resistor. The effect then is to create a complex voltage at the rectifier terminals made up at each instant of whichever voltage is higher, the complex voltage, therefore, being always higher in average value than either voltage taken by itself. It will be appreciated then that in some ways the introduction of back e.m.f. is opposite to that of inductance: back e.m.f. can produce discontinuity and in so doing elevate the rectifier voltage above its basic resistive value, while inductance can produce continuity and in so doing depress the rectifier voltage. In practice such conditions as this are found in free-firing, resistance-controlled battery chargers; in grid-controlled battery chargers; in free-firing rectifiers for feeding uncontrolled d.c. motors; and in grid-controlled rectifiers for feeding variable speed d.c. motors. Whereas the general solution to such circuit problems as arise in cases like this (and which can result in special curved regulation lines where variation of back e.m.f. is used to vary the load current) have been dealt with in papers by J. C. Read[1] and K. P. Puchlowski[2], it is proposed to make a few qualitative comments with particular reference to the effects of practical importance.

### *Free-firing Battery Chargers*

Since current may be varied by both a change of resistance and by a change of back e.m.f. we are concerned with two regulation curves when free-firing resistance controlled battery chargers are under consideration. The first shows the effect of controlling the current when initially putting a battery on charge, and the second, the change of current and voltage as the battery voltage increases with charge and with the control resistance remaining in a fixed position.

In the first place the open circuit voltage will have the complex value referred to before and the regulation curve will tend to level out at the battery voltage or the rectifier average voltage (according to curve DC†) whichever is higher—with the value of inductance deciding the current at which this occurs. This means that the voltage difference between no load and full load will be little greater than that caused by the basic rectifier regulation.

In the second case the same remarks apply but since the back e.m.f. is changing, the voltage can change from the average value (DC) of the rectifier output to its peak value (ABC).

A further point of interest to note in connection with resistance controlled battery chargers operating under inherently discontinuous conditions is that the voltage diminution brought about by the choke is wattless. In the absence of a choke, more resistance would be needed to achieve the same result (other things being equal) and as a consequence additional $I^2R$ losses would occur and lower the overall efficiency.

### *Grid-controlled Battery Chargers*

With a grid-controlled battery charger, the battery may be put on charge by increasing the rectifier volts up to the point where the charging current is of the required value and we are only concerned with the regulation curve which covers subsequent change of voltage and current due to increasing back e.m.f.—the resistance being of a very low and fixed value. The regulation curve will therefore have the same characteristics as the second case mentioned above except where the actual rectifier e.m.f. is discontinuous and then the regulation curve starts at the peak value of rectifier voltage (ABC) and levels out at the average value given by the curves DE on Figs. 4 to 7.

### *Free-firing Rectifiers Feeding D.C. Motors*

Where the back e.m.f. is due to a separately excited shunt motor we may safely assume its wave-form to be a

* *Hackbridge and Hewittic Electric Co., Ltd.* *The first part of this article commenced on page 343 of our issue of 11th March, 1954.*

† *Fig. 5, repeated here, is representative of Figs 4 to 7 which appeared in Part 1.*

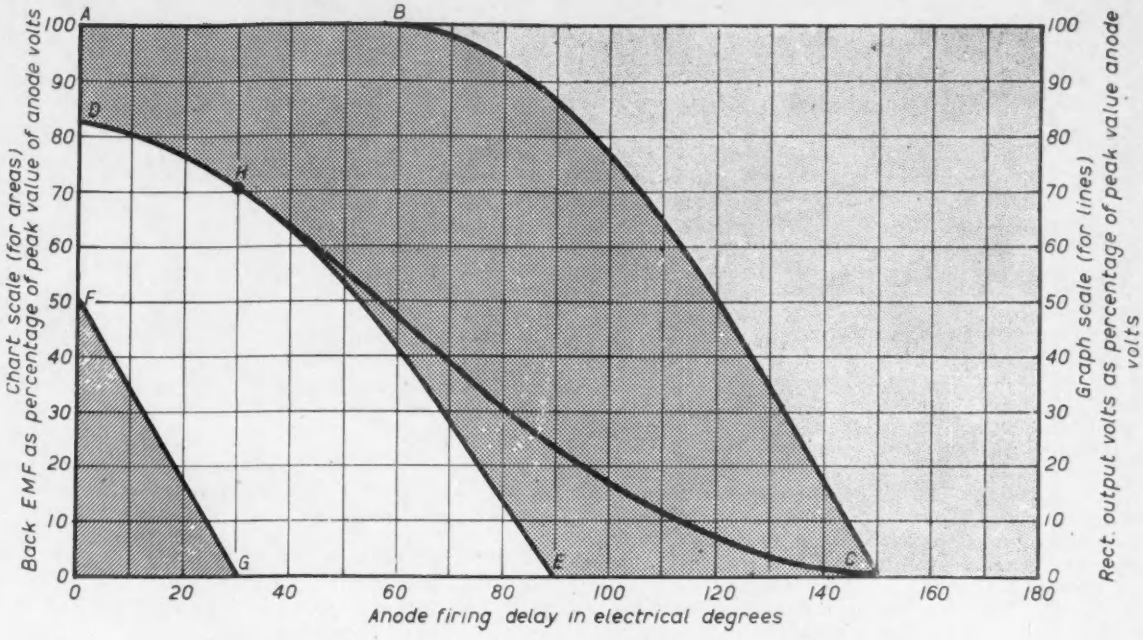



*Fig. 5. Chart for a three-phase grid controlled rectifier with load containing a back e.m.f. component*

straight line. This is so because the commutator ripple is small enough to be neglected, while the motor will have sufficient inertia to smooth out cyclic speed variations to negligible proportions as well. Unlike the previous cases however, this back e.m.f. is a dependent variable and the motor speed and back e.m.f. are self-adjusting according to the supply received from the rectifier. From a consideration of voltages only, then, we have the condition where an undulating rectified supply is opposed by a dependent straight line back e.m.f. Now in the usual practical case the motor circuit resistance will be quite low in ohmic value and even if the back e.m.f. only reached a value near the average rectifier voltage, inherent discontinuity would result. In actual fact inherent discontinuity is made more certain than this because whereas the motor receives energy during the instants when the rectifier voltage is higher than the back e.m.f. it cannot give up energy during the instants when it is lower. This results in the back e.m.f. tending to the peak value of the rectifier voltage and not to the average value—but it can only reach the peak value in the case of a motor with zero windage and frictional losses.

In this case, then, the regulation curve starts from a no-load voltage equal to the peak rectifier voltage (ABC) and levels out at a voltage equal to the average rectifier voltage (DC) as inductance brings about continuity. Because the motor will have a finite no-load current, however, the no-load condition is never reached, but unless sufficient inductance is present to bring about continuity at the motor no-load current, the voltage will be above nominal value and the motor will run at above its normal no-load speed, only to drop to correct speed at a load which does bring about continuity.

In the case of a self-excited shunt motor this effect is not so pronounced, because a high armature voltage is accompanied by a high field voltage and the motor speed necessary to develop the same back e.m.f. is lower.

With a series motor, we cannot assume its wave-form of back e.m.f. to be a straight line. This is so because any variation of current is accompanied by a variation of field strength with the result that the motor back e.m.f. tends to follow the undulations of the rectifier voltage. It is impossible, then, for the motor back e.m.f. to be higher than the rectifier voltage (at any instant) because this would result in zero current and zero excitation. This means that the current will always be continuous (even neglecting inductance) and therefore a series motor does not modify the basic resistive regulation curve.

## *Grid-controlled Rectifiers D.C. Motors*

These applications are usually confined to separately excited shunt machines but the same remarks apply as in the case of free-firing rectifiers mentioned above. Here, again, continuity brought about by inductance results in the regulation curve levelling out at the voltage corresponding to the curve DE on Figs. 4 to 7 where the rectifier e.m.f. itself is discontinuous.

The author's thanks are due to Hackbridge and Hewittic Electric Co., Ltd., for permission to publish this article.

## *Appendix*

Throughout this article the usual assumption has been made that the arc voltage drop is constant and at no-load has the same value as at full load (except where it is effectively lowered by discontinuous conduction). In actual fact, of course, at absolute no-load the arc voltage drop is zero, but as the current taken by a voltmeter is *usually* sufficient to bring about the full arc drop the assumption is a reasonable one. It will be found, however, that when measuring the open circuit voltage of a rectifier the result obtained may depend upon the resistance of the voltmeter. If a voltmeter of high sensitivity is used on a large rectifier the indication may correspond to almost zero arc drop, while if a voltmeter of low sensitivity is used on a small rectifier the indication will correspond to the full arc drop. It is important then that this point be taken into account when measuring the open circuit voltage of a rectifier.

REFERENCES

1. J. C. Read: "The Calculation Of Rectifier and Inverter Performance Characteristics," I.E.E. Journal, Vol. 92, Part II, Page 497.
2. K. P. Puchlowski: "Voltage and Current Relations for Controlled Rectification with Inductive and Generative Loads," Trans. A.I.E.E., 1945, Vol. 64, Page 255.

# From an engineer's notebook

THERE are certain scientific devices which always have an irresistible appeal for me; I never grow tired of reading about them and always feel an itch to play with them myself. Perhaps readers have seen the manifestation of my favourite scientific toys in certain repetition of subject matter on this page. Obviously this build-up is no more than an excuse to return once more to one of my pet subjects, in this case it is the beta ray emitter. I feel, however, the simplicity of this concept of direct conversion of atomic power to electricity, together with the breath-taking possibility of a primary electrical source of a life over twenty years, really needs no excuse. Unfortunately, present achievement falls a long way short of incipient commercial development but none the less advances are continually being made towards that goal. The latest step which has come to my notice is the use of a semi-conductor to multiply the emission of electrons from the radioactive source. In a design produced by the Radio Corporation of America the radioactive material used is strontium 90, which is a product of nuclear reactors and is noted as a source of electrons or beta rays. This strontium 90 is spread on a semi-conducting wafer of a silicon-antimony alloy at the opposite side of which is a third material forming a P—N junction and the output is taken from the two sides of this junction. The special feature claimed for this design is the multiplying effect of the semi-conductor; which provides some 200,000 low speed electrons at the P—N junction for every one emitted from the strontium. Fundamentally, the output of even this cell is limited and on open circuit it develops no more than one quarter volt, and this falls considerably when giving an output approaching one microwatt. Clearly such a device has a long way to go before reaching the power field, the best we can hope for at present is a power source suitable for portable amplifiers where it may be able to work with that other semi-conducting device, the amplifying transistor.

* * *

SUBSTANTIAL progress is being made with the transistor itself, and almost as a corollary of the above note I have been reading of the effect of nuclear bombardment on the germanium of transistors. It is now well established that although transistors may be an excellent substitute for valves in some electronic or radio circuits, their frequency response may be limited. Where the current from the collector electrode is restricted by the external circuit resistance, it is found that the time of decay of this amplified current after cessation of emitter current is much longer than when there is no such limitation. It is this rate of fall of collector current that determines the maximum switching speed. Some experiments at Harwell have now shown that by subjecting the germanium to neutron bombardment a great improvement can be obtained in the speed of fall of this collector current under the limiting condition referred to. Surprisingly perhaps, this superior performance becomes a permanent characteristic of the germanium and what is more its other properties are not adversely affected. It would seem, therefore, that there is every possibility of widening the scope of the transistor as an amplifying device. Perhaps more significant, is that the day is approaching more nearly when neutron bombardment will become one of the everyday manufacturing techniques.

* * *

I SOMETIMES think that modern science is almost profligate in the multiplicity of directions from which it attacks a problem and so we find the inherent limitations of germanium in transistors not only being attacked along the line of improvement of the material itself by such methods as that given in the previous note, but by the more direct approach of finding a substitute for germanium. Judging from the published reports several laboratories are engaged in this search and the more popular field of exploration appears to be that of inter-metallic compounds from which is hoped not only improved characteristics will be obtained but the resulting material will be more easy to produce than those used at present. The work is based on study of the lattice structure of the crystals and the aim is to produce a high mobility of the lattice within such other limitations as susceptibility to temperature. Compounds of antimony, aluminium, cadmium, indium and gallium are among those under investigation and one report specially favours indium-antimony which it is believed should permit operation at much higher frequencies and also with greater power outputs. At present however, the materials are not available in a sufficient degree of purity for realisation of these aims but every confidence is expressed that with a relatively large field of compounds yet to be explored, great advances are to be expected in the semi-conductor field which itself is rapidly expanding as shown in the first note this month.

* * *

BUT enough of semi-conductors! I feel I have dwelt overlong in this fascinating field and must (for the moment at least) come back to the mundane subject of the resistance of a piece of metal. We have all experienced how resistance can vary with the condition of the metal whether it be hard or soft and now attempts are being made to use the resistance as means of determining the crystalline state of the metal. Unfortunately there are so many factors in a metal that can affect its resistance that it is not easy to sort them out so as to ascertain which is responsible for the resistance change. One approach is to stress the material and in some (to me) miraculous way the type of lattice defect can be identified from the resistance measurements. Another method utilises heating and then quenching to increase the defects, while a third involves irradiating the metal by beta rays which ionise the interstitial spaces and so accentuates any defects. The very variety of methods available makes me doubt their significance. Certainly they sound as though they should never be allowed to escape from the laboratory, so we still have not found that simple routine method of making sure material is of the right grade for production.—*E. R. G.*

# The Toronto Subway

*Yonge Street System to open on March 30th*

THE end of this month should see the completion of the Toronto rapid transit service between Union Station and Eglington Avenue, a distance of some 4½ miles. About 2¾ miles of this route is located below Yonge St, the remainder being in open cut sections along private rights of way parallel with Yonge St.

The contract for the supply of 104 rapid transit cars required for the railway was awarded to the Gloucester Railway Carriage and Wagon Co., in face of keen competition from Canadian, American, Continental and other manufacturers.

Apart from the two terminal stations, there will be ten intermediate stations, each with platforms 500 ft long. A 3-aspect automatic block signal and interlocking system is being installed by Siemens and General Electric Railway Signal Co., and is designed for a two-minute headway with 8-car trains.

## Traction Motors

The main traction equipment has been supplied by Crompton Parkinson and comprises 440-68 h.p. traction motors; 55 motor-generator sets and batteries for the 50 V auxiliary services, and cable for certain of the power wiring. The motors are series wound and operate with pairs permanently connected in series across the 600 V supply. Designed to operate with field diversion to give fast running the motors will accelerate a fully "crush-loaded" car at the high rate of 2 m.p.h./sec and are capable of producing a top speed of about 55 m.p.h.

Four traction motors are fitted to each car so that every axle throughout the train is powered. As the motors are frame mounted provision has been made for relative movement between axles and motors by means of cardan shafts having rubber universal joints at each end, and as the motors are mounted with their axis parallel to the rails, a right angle drive gear box is used on the axles. A sliding joint at one end of the cardan shaft accommodates longitudinal movement.

The general construction of the motors is conventional, although the usual long cables have been eliminated by the provision of quickly detachable connecting posts to facilitate removal of the motors for maintenance.

## Control Equipment

Control equipment has been supplied by the British Thomson-Houston Co., and provides for series-parallel control of the traction motors, which are arranged in pairs. The line breakers, camshaft accelerating unit, reverser, series-parallel transfer switch, field shunting contactors and relays are mounted in an aluminium-alloy framework carried on the underframe. The system adopted comprises a number of contactors operated by a camshaft which dictates the order of closing. The camshaft is rotated by a rack which engages with a driving pinion, the rack being mounted between two pistons in a cylinder. One piston operates under air pressure and the other under oil. Initially the camshaft notches up under oil pressure in nine steps to the full series position, and at this point a series-parallel transfer switch operates to connect the motors in parallel, each with its own section of resistance reinserted. Pressure on the oil is then released, the air cylinder takes over and the camshaft rotates in the opposite direction, again however cutting out sections of the starting resistances. Overloading is prevented by a current relay which arrests the movement of the camshaft by an electro-magnetically-operated pawl which engages a star wheel on the shaft. Automatic testing is provided so that the equipment may be checked without the application of power to the motors.

The lightweight starting resistors comprise ten BTH Type RP units manufactured from edgewise-wound aluminium chromium alloy steel strip of high specific resistance and low temperature coefficient.

## Cab Equipment

Only three operating positions are provided for the master controller of the shallow desk type mounted in the cab. In the "shunt" position all four motors are connected in series with the starting resistance. In the "series" position, the resistance is all cut out and the motors are in series across the supply, and in the "parallel" position the motors are connected in series-parallel across the supply. Field shunting is carried out automatically under current control in the "parallel" position. By means of an accelerating rate switch the driver can select any one of three accelerating rates. Thus he can maintain acceleration under varying load and rail adhesion conditions.

On the right of the master controller, which is mounted for left-hand operation, is the electro-pneumatic brake controller. Two mercury retarder switches which control the rate of braking are mounted above the cab door. In the corner of the cab, six pushbuttons are located for door control and

*Components of the Crompton Parkinson traction motors showing stater left, and armature below*

*One of the trains emerges from the subway*

inter-car signalling, and flush-mounted in the left-hand corner pillar are two brake pressure gauges, a battery voltmeter and a bank of six coloured miniature indicator lamps. Two green lamps indicate doors shut, two orange lamps prove the electro-pneumatic brake and retarder supplies, a red lamp indicates if a motor generator is not operating and a blue lamp lights when all traction control units on the train have operated to the final parallel position.

Eight pushbuttons on the right-hand corner pillar provide motor generator "start" and "stop," "signal bell," "couple" and "uncouple," "overload set" and "overload trip and test", and "driver's switch shunt." This last enables the motor generator to be used when the driver's switch is not closed.

### *Auxiliary Equipment*

The motor-generators are arranged so that one unit supplies two cars. They are of Crompton-Parkinson manufacture and consist of two armatures and two commutators on a single shaft. The rated output of each set is 4 kW at 52 volts, at any input voltage between 450 and 600 volts. The motor has only series excitation and, in the interests of stability when passing conductor rail gaps, is without shunt or separate speed limiting windings. Its speed on light load is limited by fitting cooling fans at both ends of the armature, and on rise of machine speed, the increasing power absorption of the fans effectively prevents dangerous values of rotation being attained.

A 96 ampere-hour (5 hour rating) lead-acid battery, also by Crompton Parkinson, floats across the output of the generator, and a carbon-pile regulator adjusts the generator field to provide a constant voltage input to the battery. Inherently, this can be maintained to a variation of $\pm\frac{1}{2}$ volt, but a decompounding coil is included in the regulator which effectively limits the maximum overload current from the generator into the battery.

The project as a whole was begun some four years ago and at that time was estimated to cost about $83 million.

# An 8 MeV Linear Accelerator

## *High Voltage X-Ray Equipment at Hammersmith*

IN our issue of 22nd October, 1952, we gave a short description of the Metropolitan-Vickers, 8 MeV linear accelerator which has been installed at Hammersmith Hospital. This super-voltage X-ray therapy plant is being used for research into the treatment of cancer and other diseases. The demand for machines operating at these high energy levels is due to the greater depth of optimum dosage that becomes available, together with a diminution in the length of time taken for irradiation. In the orthodox X-ray tube, the full accelerating voltage is applied between the cathode and the final anode.

It was, however, decided in connection with the Hammersmith plant to use a linear accelerator in which electrons could be bunched and accelerated by suitable travelling accelerating electromagnetic fields. A detailed description of this equipment was given by Mr C. W. Miller, in an I.E.E. paper presented last week under the title of "An 8-MeV Linear Accelerator for X-ray Therapy." The basic design was founded on an accelerator 3 metres long using r.f. power with a free space wavelength of 10 cm and giving at 10 MeV an electron beam with a mean current of 15 microamps.

The accelerator consists of a corrugated waveguide, the corrugations being so dimensioned to provide the necessary accelerating field. The sections were built up from elements which were brazed as a stack using eutectic alloy. Each element was machined from the solid and tolerances of ± 0·0003 in. were maintained. When measurements were taken on the first section of the accelerator, the phase velocity was found to differ from the computed value, causing a phase error of some 36°. It was decided however to use this section, and in the meantime to redesign on the basis of the experimental results. When however a length of uniform waveguide for the output end of the machine was measured a discrepancy was again found, and this was unexpected as a more exact theory had been used. Investigation showed that the error arose due to the use of incorrect limits of integration in the matching of fields at the mouths of the corrugations. The final equipment gave an output of about 8 MeV.

### DISCUSSION

The discussion was opened by MR D. W. FRY (A.E.R.E., Harwell) who emphasised the need for the design of such equipment to be kept as simple as possible. In the machine described about 10-12% of the r.f. power was being fed into the system. Subsequent experience had shown that this could be increased to 40%. MR G. R. NEWBERY (Hammersmith Hospital) said that the plant had been most satisfactory. Since September last, 100 patients had been treated with 2,000 individual treatments. The magnetrons had behaved extremely well, although trouble had been found with some of the ignitrons. MR M. G. KELLIHER (Mullards) suggested that it would be necessary to use a different accelerator system and feed-back device for higher powers. These had been embodied in a machine giving 12–13 MeV. The design of the corrugated waveguide was considered by MR W. WALKINSHAW, and DR F. T. FARMER dealt with the importance of keeping the electric beam centred on the target. MR G. SAXON (Metropolitan Vickers) also remarked on the difficulty of controlling the beam and considered that for an accelerator of given frequency tolerance it was possible to get more power into the beam without feedback. Manufacturing technique was the subject of MR M. C. CROWLEY-MILLING'S remarks. It was difficult to maintain close tolerances during brazing operations. The author briefly replied.

# Fluorescent Lighting in Central London

## *Holborn Converts to Electricity after 100 Years of Gas*

THE largest London street lighting scheme using fluorescent lamps was formally opened last week by the Mayor of Holborn, Councillor J. C. St Lawrence Stallwood, J.P. Holborn, as is well known to most Londoners, lies to the west of the City, and through it passes one of the main routes to the west. In 1839, indeed, so important was this route, which at that time was a winding one via High Holborn and St Giles High Street into Oxford Street, that Parliament made provision in a Metropolitan Improvements Act for building, through an appalling slum area—"the Rookeries"—a new street which now is called New Oxford Street.

For more than 100 years, this area, including New Oxford Street, has been lighted by gas—with changes in equipment as technical improvements in gas lighting were made. Now, it has modern lighting provided by fluorescent lanterns made by the General Electric Co., Ltd. The actual installation lights not only New Oxford Street and St Giles Circus, but also part of Kingsway, Shaftesbury Avenue, Southampton Row, Charing Cross Road and Tottenham Court Road. In all 108 lanterns are used. These are of the G.E.C. "Four Eighty" type, wired for instant start. Each lantern houses four Osram 5-ft 80-watt 240 volt "Daylight" fluorescent tubes. Mounting height is 25 ft, and 86 of the lanterns are on single arm columns and 22 on double arm columns.

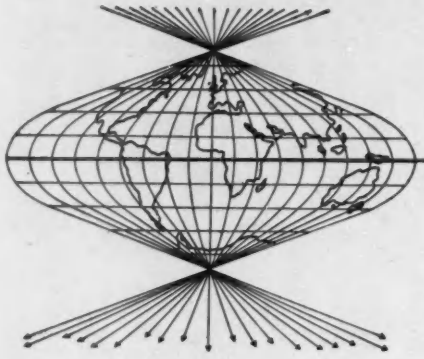
Provision is made for "Half" night lighting whereby two of the tubes in each lantern are automatically switched off by a time switch at 1 a.m. when traffic is at a minimum.

Erection began on 4th January and was completed on 1st March. Some of the columns used were originally put in for the gas lighting, and in addition to the main installation the G.E.C. also supplied and erected seven central island tubular steel columns each carrying a 12 in. dia opal globe housing one 200 watt Osram tungsten lamp.

The work was done with the co-operation of the London Electricity Board and the North Thames Gas Board. The G.E.C. staff worked closely with Mr K. C. Iliffe, LL.B., A.M.INST.C.E., engineer and surveyor to the Holborn Borough Council and his assistants Messrs W. Dainton and J. A. T. Reeder.

Speaking at an informal party held after the inauguration of the lighting installation, the Mayor of Holborn mentioned that although Holborn was a small borough in size, it covered a most important part of London. He regretted that in some streets, notably Charing Cross Road, there was an abrupt change from fluorescent lighting into high-pressure gas, and he hoped that Westminster would soon fall into line. Mr. W. H. Williams of the General Electric Company also gave a short speech in which he emphasised the great benefit which could be realised from good street lighting particularly as a means of preventing accidents.

*The excellence of the lighting is shown in this view looking eastward along New Oxford Street from the Tottenham Court Road crossing*



# OVERSEAS NEWS

*A SUMMARY OF IMPORTANT EVENTS*

## CANADA

### Buttle Lake Plan Proceeds

The British Columbia Power Commission is to proceed with construction of the Buttle Lake storage dam as fast as the work can be organised. The Water Comptroller has now approved the Commission's plans for an earthfill dam at the outlet of the lake. The dam will increase water storage for the Commission's John Hart power development, permitting full economic utilisation of the hydro resources of the Campbell River, the best electric power source on Vancouver Island. It is estimated that the dam will be completed by the end of 1955. The question of building this dam has been the subject of bitter local controversy for the past two or three years.

### Manitoba's Good Year

The rapid strides being made by the Manitoba Power Commission are clearly indicated in the annual report covering the year ended 31 Mar. 1953. With its territory continually expanding, the Commission was serving a total of 461 cities, towns and villages at that date. Units sold, totalling 377·1 millions, were 15·9% higher than for the previous year, and 10,536 new service connections were made bringing the total number of consumers to 87,858. Operations for the year resulted in a surplus of $483,025. Domestic and farm consumers provided the major portion of total revenue, but the water heater flat rate was responsible for $188,899 of the total—about 10% more than in the previous year. The doubling of the Commission's peak demand in the past three years has necessitated a heavy programme of system improvements. The 115 kV transmission line from Parkdale to Portage la Prairie has been duplicated, and additional 66 kV lines have been erected, apart from major improvements to the distribution system.

### Against Foreign Invasion

The recently concluded agreement for the supply to the British Columbia Electric Co., Ltd., by British Insulated Callender's Cable Ltd. of submarine cable to a value of over $3 million (noted in 11 Feb. issue), "would obviously come under the category of dumping if the Minister of National Revenue chose to exercise his powers under existing customs regulations," Mr B. N. Simpson, president of the Canadian Electrical Manufacturers' Association, has declared. The B.I.C.C. tender was about $1,000,000 lower than that of any other British or Canadian manufacturer, it is stated. Mr Simpson maintained that the difference in price was due to the importation of custom built equipment from a low labour cost country. Labour costs in Britain were approximately 53 cents per hour against a minimum of $1·60 in the electrical manufacturing industry in Canada, he said, adding that it was their belief that if employment was to be maintained in Canada, the greater portion of the domestic market must be retained for Canadian industry, at least until other signatory powers to the G.A.T.T. agreement fulfilled their obligations and made available again the export markets Canada formerly enjoyed.

### Ferranti's Acquisition

We learn that Ferranti Ltd. have acquired control of the Canadian power transformer manufacturing concern, Packard Electric Co., Ltd. Under this arrangement the output of the company in Canada will be doubled, it is stated.

### New Brunswick Development

Operations of the New Brunswick Electric Power Commission for the nine months ended 31 Dec. last provided a record revenue of $5,640,337—over $500,000 more than for the corresponding period of the previous year. This information was given by the Hon. Edgar Fournier, chairman, at the Commission's meeting recently. There was an operating surplus of $18,433 for the period. He attributed the largest percentage of the just over 10% gain in revenues to increased consumption of industrial power.

## AMERICA

### "Packaged" Atomic Stations?

It seems that America is to put to the test the idea that "packaged" atomic power stations could be built in out-of-the-way spots. The U.S. Atomic Energy Commission has approached private companies to ascertain if they would be willing and able to erect an experimental version of small nuclear power plants, such as could be established in remote areas like the U.S. air bases in Alaska and Greenland, where the provision of fuel for heat and power is now a major problem. The nuclear plant being considered, it is stated, is based on a preliminary design study made at the Commission's Oak Ridge laboratory.

### Another Project

It was also announced last week-end that the U.S. Atomic Energy Commission was negotiating with the Duquesne Light Co., of Pittsburgh, to build and operate a nuclear plant to produce electricity. The company, which operates in the greater Pittsburgh district, is to provide the site, build and operate the atomic power station, at no cost to the government. In making this announcement, the Commission added that this proposed power station was not expected to generate electricity at a cost competitive with other fuels. The project is to be undertaken to gain more design and technological experience, and to provide firm cost estimates for the future.

### Cash for Cuba

To permit the Cuban Electric Co. to expand its generating plant, the United States Export-Import Bank has announced an additional credit of $12,000,000 to the company. The additional credit, the Bank said, would assist the concern to purchase United States materials, equipment and services estimated to cost $28,000,000. To meet the island's demands for power, the company had undertaken a $51,000,000 expansion programme to increase its generating capacity by 84,000 kW. The new credit would be consolidated with an existing credit of $12,000,000 made by the Export-Import Bank in 1951.

## EGYPT

### Station Tenders

For the construction and equipment of the Cairo South power station for the Egyptian Government a number of foreign companies submitted tenders, but there was none from any United King-

dom concern, we understand. The lowest tender is that of the French steel company "Schneider," we learn. The offers for the complete installation varied between £E3,498,000 and £E6,308,000. No contract has yet been placed.

### Looking Ahead

State Governments in India have recently been invited by the Central Technical Advisory Committee on Irrigation and Power Projects to submit detailed project reports on schemes they suggest be included in the second Five Year Plan. The project reports are to be prepared on the lines indicated in a comprehensive manual on irrigation and power projects under compilation by the Central Water and Power Commission. Adherence to the instructions and requirements laid down in the manual will ensure that all the projects are drawn up with a degree of technical and financial thoroughness that has not always been evident in the past. The suggested schemes will be technically examined by the Central Water and Power Commission who will report on their findings.

### A Supply Problem

The French Ambassador in New Delhi has been instructed to draw the attention of the Indian Government to the repercussions of the non-renewal of the agreement under which India supplied electricity to French India, the French Foreign Office has announced. The stoppage of electric power supplied by Indian power stations to the French enclaves of Pondicherry, Karikal, Aman and Mahe considerably hampers irrigation of ricefields as all the pumps are electric.

### Licence Wanted

We have already reported that the Delhi Municipal Council is seeking a licence to permit it to operate the electricity distribution system within its area. We now learn that the matter is likely to be considered by the Delhi State Government very shortly. If a distribution licence is granted to the Municipal Council its present income is expected to be increased by nearly Rs. 10 lakhs annually. Apparently the question of granting the licence is to be considered when the State Government is considering reorganisation of municipalities.

## AUSTRALIA

### Work at Bunbury

Work has now begun on the site for the construction of the first stage of the Bunbury power station for the State Electricity Commission of Western Australia. Installed capacity of this section will be 120 MW, but ultimate development may be 400 MW, making it the largest station in Western Australia. Output will be fed into the south-west system network at 66 k and into the Perth metropolitan area by means of 132 kV transmission lines.

### Utilising a Catastrophe

The recent flooding of vast areas of Queensland caused by the cyclone and torrential rain, was put to some use by the Capricornia Regional Electricity Board. A complete aerial photographic survey was made of the Board's 32,000 square miles of area, much of which was flooded. Officials photographed flood-free areas to guide the board in selecting sites for substations and transmission lines. The Board has a £1,000,000 works programme this year, and, with the approval of the State Electricity Commission, will undertake a £1,250,000 programme next year.

### The Railways' Loss

Transfer of the New South Wales Railway Department's electricity undertakings to the State Electricity Commission reduced the Department's earnings in 1952-53 by £3 million, it is disclosed in the Railway's annual report. In recent months the Department transferred to the Commission its four steam power stations at White Bay, Ultimo, Newcastle and Lithgow, along with power lines supplying in bulk to various local authorities. During the year covered by the report the Railways made a loss of about £1,408,000 according to Mr R. Winsor, Commissioner for Railways. One cause of the deficit was the loss during part of the year of income from electricity sales.

## NEW ZEALAND

### Geothermal Station Site

If foundation tests prove satisfactory, the site for New Zealand's first geothermal power station has been fixed, we understand. The position is on the western bank of the Waikato River, about half a mile downstream from the Wairakei Hotel. The location, 50 ft above the level of the river, was recently visited by Mr Goosman, Minister of Works, who pointed out that the capacity of the station could not be decided until better assessment had been gained of the steam output of the four deep drills (as we noted on 4 Mar.). During Mr Goosman's visit, the fourth of the deep bores (going down to 1,830 ft) was released. This is the shallowest of the four.

### A Burnt-out Problem

Perturbed at consumer's refrigerators burning out, sometimes alleged to be due to voltage fluctuation or power cuts, members of the Thames Valley Power Board, New Zealand, recently requested their engineer, Mr G. P. Lindsay, to report on a proposal to frame a by-law protecting consumers from such damage. He has now reported that legal opinion suggests that any by-law made which went beyond the Electric Wiring Regulations could very easily be upset in Court. But at the latest conference of supply authorities in N.Z., the question of a model set of by-laws, and the matter of thermal protection for refrigerators and washing machines was discussed. It was then agreed that as it involved several technical details, and other appliances, more time was required for full consideration before any definite recommendations could be made. Mr Lindsay suggested that the matter be left until those deliberations were completed. To this the Board agreed.

*One of Switzerland's latest power stations is the Verbano station, a photograph of which is alongside. This station is equipped with four vertical Francis turbines operating at 600 r.p.m., each of which is coupled to a 32,000 kVA, 12 kV generator. There are seven single-phase transformers, six of which are connected in two 3-phase groups of 64,000 kVA, 12 kV/225 kV, leaving one in reserve. The machine hall is some 70 m. long, and 20 m. wide, and has a maximum height of 30 m.*

# Personalities

## IN THE INDUSTRY

The Watford Electric and Manufacturing Co., Ltd. announces that **Mr R. M. Ll. Evans,** B.A.(CANTAB.), M.I.E.E., has recently been appointed a director of the company, subject to confirmation at the next annual general meeting of the shareholders, in addition to his executive position as chief electrical engineer. Mr Evans, prior to joining the company in 1951, was on the staff of the Director of Electrical Engineering, Admiralty, and was formerly with the Metropolitan-Vickers Electrical Co., Ltd.

**Mr E. H. Nichols** has been appointed manager of the Norwich branch of W. T. Henley's Telegraph Works Co., Ltd. as from 10 Mar., in succession to **Mr J. Newton** who has retired after 45 years' service with the company. Mr Nichols joined Henley's Head Office in 1923 and for over 21 years has been a representative at the Norwich branch.

**Mr W. Howes,** M.I.MECH.E., M.I.E.E., formerly chief engineer to Harrods Ltd., is now deputy chairman of the London Electricity Consultative Council.

**Mr Edward Binns,** M.I.MECH.E., A.M.I.E.E., who recently retired from the post of manager of No. 3 (Oldham) sub-area of the North Western Electricity Board, has joined Mr Ralph B. Giles, the consulting engineer, who was formerly electrical consultant to the Ministry of Aircraft Production. Prior to vesting day Mr Binns was chief engineer and manager of the Oldham Corporation electricity undertaking, which included the two power stations at Chadderton and Greenhill. He was a member of the team representing the Electricity Supply Industry of this country which visited the United States in 1949 under the auspices of the Anglo-American Council on Productivity. He has a particular knowledge of the application of the electric drive in the cotton industry and has been closely in touch with a large amount of the development that has taken place in Oldham and the surrounding districts.

Principal assistant in the accountancy section of the North Western Electricity Board's No. 5 sub-area, **Mr W. Kearsley,** F.I.M.T.A., has been appointed accountant of the Board's No. 2 sub-area, to succeed **Mr V. T. T. Atkinson,** A.I.A.C., who retires at the beginning of May. Mr Atkinson became No. 2 sub-area accountant on nationalisation of the industry in 1948, after over 40 years with the Lancashire Electric Power Co., for whom he was appointed chief accountant in 1945, and given the additional responsibility of assistant secretary in 1947. Mr Kearsley joined the staff of the County Borough of Wigan in 1931 and went to the Ormskirk Urban District Council in 1939 as chief internal auditor. After war service he became deputy borough treasurer at Bacup in 1946, leaving the following year to become treasurer, accountant and rating and valuation officer to Horwich Urban District Council. He was appointed to his present position in 1948.

**Mr Robert Moses** has been selected as chairman of the New York State Power Authority, it has been announced. He replaces **Mr John E. Burton.**

Santon Ltd. announce a number of changes and additions in the outside representative staff attached to their London branch office. **Mr W. Cleaver,** formerly with J. Stone and Co., Ltd., of Deptford, has joined Santon and will be responsible for rotary switch sales development; **Mr J. W. T. Rowell,** formerly of Enfield Cables Ltd., will be Santon's representative in the Eastern Electricity Board area, and **Mr D. R. Whynes,** formerly the representative in the Eastern Electricity Board area will have special duties in connection with government and export business.

Appointed as power station superintendent at Nechells "A" and "B" power stations, Midlands Division, B.E.A., is **Mr J. E. Farrington,** A.M.I.MECH.E., A.M.I.E.E., who, since 1951, has been deputy superintendent there. Mr Farrington, whose new appointment takes effect on 1 Apr. next, will succeed **Mr G. D. Clegg,** A.M.I.E.E., who, as we have already noted, is retiring. Educated at Wolverhampton Grammar School and at the Wolverhampton and Staffordshire Technical College, Mr Farrington gained early practical training as a pupil with J. Bigwood and Sons Ltd. He entered the service of the City of Birmingham Electric Supply Department in the Central Testing Department in 1933. He was appointed shift charge engineer at Nechells "A" power station in 1942 and boiler house superintendent four years later. In 1949 he was nominated assistant station superintendent at Nechells "B" power station, and was concerned with the construction and commissioning of that station. His appointment as deputy superintendent at both Nechells "A" and "B" generating stations followed two years later.

**Mr R. A. West,** B.SC.(ENG.), A.M.I.E.E., has relinquished his duties as technical director to Igranic Electric Co., Ltd., Bedford, to take up a position with Contactor Switchgear Ltd. Educated at Oundle School, Mr West served his apprenticeship with Igranic and after several years training in the works and offices, was transferred to the company's Scottish branch as branch manager, which position he held for 17 years. He returned to Bedford in 1948 as assistant to the managing director, and became technical director the following year. Mr West is the author of *Electrical Traction for Cranes,* and of numerous technical papers on small switchgear and its applications and associated subjects.

*Mr E. H. Nichols*

*Mr W. Cleaver*

*Mr J. W. T. Rowell*

*Mr D. R. Whynes*

*Mr R. A. West*

The Skefko Ball Bearing Co., Ltd., announces that **Mr E. Y. Caswell** has relinquished his duties as manager of the Bristol district to join the executive staff at the company's head office as sales manager. Mr Caswell began his career at Skefko at their Birmingham office in 1931, becoming assistant district manager in 1937, and district manager at Bristol in 1946.

General manager of De Beers Consolidated Mines Ltd., **Mr H. H. Taylor** has been nominated by the company as consulting engineer to the Kafue hydro-electric scheme.

**Mr George Pool,** who is to be manager of the new factory being built at Whyalla, South Australia, for C. A. Parsons and Co., Ltd., Newcastle-on-Tyne, is senior superintendent of erections for the company. He was previously head of the production research group and manager of the company's pipework division.

To mark his retirement from the post of district engineer at Middlesbrough to the North Eastern Electricity Board, **Mr R. Hodgson** was recently presented with a bureau bookcase and a grandfather clock. Mr Hodgson was connected with the industry for 33 years, being on the staff of the Middlesbrough corporation undertaking prior to nationalisation.

**Mr R. F. Gyngell,** secretary of W. T. Henley's Telegraph Works Co., Ltd., is to retire at the end of this month after 42 years' service. His successor will be **Mr S. J. Beaney,** the present assistant secretary.

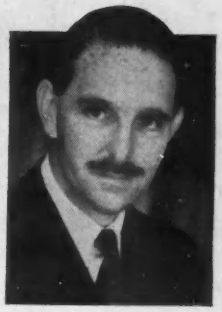
**Mr A. C. Brand,** manager of the Stratford-on-Avon district of the Midlands Electricity Board was among fifty members of the staff and employees who recently received awards and long service certificates. Mr Brand completed 40 years' service in the industry last November. He started his career in 1913 with the old Shipston-on-Stour Electric Co. and after war service returned to that company as engineer-manager, and remained as manager with the undertaking when it was acquired in 1928 by the Shropshire, Worcestershire and Staffordshire Electric Power Co. After a period at Smethwick and at Redditch as district manager, he returned to Stratford in 1939 in a similar capacity, retaining that appointment after vesting day. At the function, **Mr E. C. Eades,** the deputy district manager at Stratford, received an award for 26 years' service, and **Mr J. Tarver,** the district commercial officer, an award for 28 years' service.

Ekco-Ensign Electric Ltd., have appointed **Mr R. F. Cook** as their representative covering the county of Kent, and **Mr L. J. Weingard** in a similar capacity for part of Manchester and immediate surrounding districts.

The Revo Electric Co., Ltd., announces the appointment of two further demonstrators. They are **Miss Janet Evans** and **Miss Doreen Lakin.** Miss Evans was, before nationalisation, with the North-met Power Co., and the County of London Electric Supply Co. and has recently returned from 5 years' service with the East African Power and Light Co. Miss Evans will be based on Revo's London office, and will be responsible for demonstrations in London and the South. Miss Lakin, who will operate from Revo's head office, will be responsible for the Midlands and East Midlands territories. Previously, Miss Lakin served with the Midlands Electricity Board at Walsall. As senior housecraft adviser, **Miss Mary Hartop** is in charge of the firm's demonstration staff.

*Miss J. Evans*

*Miss D. Lakin*



*Mr P. M. Hollingsworth*

**Mr A. W. Montgomery,** joint general manager of Standard Telephones and Cables Ltd. has been elected a Fellow of the U.S. Institute of Radio Engineers for his radio and telecommunication research in England.

Tube Investments Ltd. has announced that for personal reasons, **Mr N. G. Lancaster** has relinquished his appointments as a director of the company, and of its subsidiary and associated companies, as from 13 Mar.

**Mr M. Burningham** is relinquishing his office as managing director of Keith Blackman Ltd. with effect from 1 Apr., but will retain his directorship and remain chairman of the company. **Mr D. S. Woodley** has been nominated managing director as from 1 Apr.

We learn from the Metropolitan-Vickers Electrical Co., Ltd. that consequent upon the transfer of **Mr C. P. Storr** to the Dominions Division of Metropolitan-Vickers Electrical Export Co., Ltd., **Mr J. G. Miles,** B.SC. (ENG.), has been appointed the company's power systems engineer. Educated at Judd School, Tonbridge, and at Brighton Technical College, Mr Miles obtained his degree at London University. He went to Metropolitan-Vickers as a college apprentice in 1948, afterwards joining the Instrument and Meter Engineering Department. In 1951 he was awarded an A.E.I. Fellowship to the General Electric Co., Schenectady. Following short periods spent successively in the Switchgear, Plant and Transformer Engineering Departments, he joined Mr Storr on the latter's appointment as power systems engineer early in 1953.

Manager of the Radio and Television Department of the General Electric Co., Ltd., **Mr M. M. Macqueen** has been elected chairman of the British Radio Equipment Manufacturers' Association. As we noted last week, Mr Macqueen sailed for the U.S.A. on Saturday to examine developments there, including colour television.

**Mr P. M. Hollingsworth,** M.ENG., M.I.E.E., MEM.A.I.E.E., has recently been appointed chief engineer of the Power Cables Division of British Insulated Callender's Cables Ltd., to succeed **Mr W. P. Fuller** on his eventual retirement. Educated at Stonyhurst College and Liverpool University, Mr Hollingsworth entered the cable industry in 1928 when he joined the outside engineering staff of British Insulated Cables Ltd. Two years later he was transferred to the Research Department at Prescot, where he was engaged in the testing and development of high voltage cables. He joined Johnson and Phillips Ltd. in 1938 as head of the Paper Cable Test and Research Department, and during the war took charge also of technical work on thermoplastic cables supplied to the Services. Immediately after the war he was appointed cable test and research manager of the company, with control of engineering and development for all types of cables, and in this capacity played a leading part in the introduction of aluminium-sheathed cables in 1948. Mr Hollingsworth's new appointment involves responsibility for the design and quality of power cables of all types and for applied research on cables and materials.

Nearly 400 apprentices and guests attended the annual dinner of the G.E.C. Witton Apprentices' Association at the Magnet Club, Witton, recently. Among the guests were **Mr R. C. Giggins,** a director of the General Electric Co., Ltd., and **Mr J. Wilson,** principal of the College of Technology, Birmingham. The toast of "The Association" was proposed by Mr R. C. Giggins, who presented a complete set of the War Memoirs of Sir Winston Churchill to the Apprentices' Library at Castle Bromwich Hall. The chairman of the Association, Mr R. C. Beard, a graduate apprentice from Australia, responded. Mr D. L. Davies, vice-chairman of the Association, proposed

*Mr R. C. Giggins hands over the apprentice's cup to Mr. D. Ainsworth*

the toast of "The Guests," to which Mr J. Wilson replied. Our accompanying photograph shows Mr R. C. Giggins presenting one of the many awards to apprentices during the evening. The winners of this year's awards were: *Best Apprentice*: (trade) S. Davis; (drawing office) L. Coulthard; (student) S. Parker. *Best All-round Sportsman Cup*: P. Commusky. *Journal Prizes*: (articles and verse) J. Remfry; (cartoons) D. Hansford. *Apprentice's Cup*: D. Ainsworth.

The Illuminating Engineering Society has conferred honorary membership upon **Sir John Herbert Parsons,** the famous opthalmologist. Sir John, who is 85, is a past-president of the Society and was the first chairman of its Council. He is the oldest living founder-member of the Society and past-president of the Society, He was present at the informal dinner in Feb. 1909, when it was decided to form the Society, and he was actually invited to become its first president. He declined that invitation, however, because he felt that, during its inaugural year, it would be more fitting if an engineer rather than an ophthalmologist held office.

The Western Australian Under-Treasurer, **Mr A. J. Reid** has been appointed

*Mr G. Leslie Wates, right, presents an award*

as acting-chairman of the State Electricity Commission to replace **Mr R. J. Dumas** who resigned as chairman and a member of the Commission a few days ago. Mr Reid is to act as chairman of the Comimssion for the remainder of Mr Dumas's term, which would expire on 21 Mar.

At the "Apprentices' Night" recently held for the third successive year by Johnson and Phillips Ltd., **Mr G. Leslie Wates,** J.P., COMP.I.E.E., chairman of the Board of Directors, made a brief but encouraging speech. He was followed by **Mr W. Glass,** joint managing director, who referred to his recent visit to Russia. As our accompanying photograph shows, awards were then presented by Mr G. Leslie Wates to apprentices who topped the list in their respective grades during the year. Amongst them, medals were given to **D. T. Perkins** (bronze medal), **D. J. Maynard** and **F. R. Craddock** (silver medals) and **D. M. Martin** (gilt silver medal).

At present station superintendent at Kirkstall power station, Leeds, Yorkshire Division, B.E.A., **Mr R. C. Hodson,** ASSOC.I.E.E., M.INST.F., has been appointed to a similar position at the Division's Skelton Grange power station. He will take up his new duties on 1 Apr. Mr Hodson started his career with the Leeds Corporation electricity undertaking and held various posts at the Whitehall Rd and Kirkstall power stations, progressing to deputy station superintendent and power station superintendent at Kirkstall power station. He took over the latter post in September 1952 on the retirement of **Mr R. J. F. Sarvent,** A.M.I.E.E.

## OBITUARY

**Mr W. H. Moore,** late contract manager of Pirelli-General Cable Works Ltd., died on 13 Feb., aged 75.

**Mr H. W. Ashton,** A.M.I.E.E., for many years resident engineer and manager to the South Cumberland Electricity Supply Co., died on 13 Mar. He retired in 1949.

# *Indicating Instruments Standard undergoes Revision*

UNDOUBTEDLY, the most noticeable change in the recently issued revised edition of "Electrical Indicating Instruments" (B.S. 89:1954) is the new classification of meter types. The earlier categories of "sub-standard" and "first-grade" instruments are superseded by "precision" and "industrial" classes. In these two grades the former is capable of a higher degree of accuracy but in the "industrial" grade there is now provision for instruments which combine the robustness required for general industrial use with a reasonable degree of accuracy. The standard thus goes some way toward satisfying two distinct needs, one for instruments of the highest attainable accuracy and the other for instruments of robust construction and minimum cost. It should not be forgotten, however, that the accuracy prescribed in this revised standard is not the highest which may be obtained with British instruments.

### *Methods Simplified*

Looking at the standard as a whole, it is seen that, as against the 1937 edition, there has been a simplification in the method used to define limits of error which themselves have been more closely associated with the type of movement employed. Precision instruments (originally sub-standard) are less affected in this simplification, although the earlier edition provided for three classes of movement (permanent magnet moving coil; electro-dynamic; and all other) which has now been reduced to two, electro-dynamic being included with "all other types." No distinction, in this class, has been drawn between single and multi-range voltmeters—they are both required to have a limit of accuracy of 0·3% of the scale range, the same limit also applying to millivoltmeters (whether single or multi-range) and single-range ammeters. Multi-range ammeters have a limit of accuracy of 0·5%. The classification of precision wattmeters has been simplified to some extent and the limit of accuracy of double-element types being a little closer.

Industrial grade instruments, however, in their classification of accuracy limits bear little relation to the first grade instruments of the 1937 edition. Broadly they are divided, for this purpose, into two groups—switchboard and portable—and subdivisions in each group are based on the type of movement rather than on the use of the instrument. Further, the previous arrangement of specifying two limits of accuracy, one for the lower, and the other for the upper half of the scale range has now been abandoned. Thus, for industrial switchboard instruments, p.m., m.c. voltmeters, millivoltmeters, ammeters, milliammeters and microammeters of scale length of 3½ in. or greater are required to have an accuracy limit of 1·0%, limits for 2 in. and 1½ in. scale lengths being 2·0% and 2·5% respectively. Similarly moving iron, electro-dynamic, induction, thermocouple, rectifier and electro-static instruments are given other limits of accuracy, these being determined by scale length and instrument. Accuracies of industrial portable instruments follow identical classifications.

### *Preferred scale values*

One of the new features of the standard is seen in tables giving preferred full-scale values of ammeters and voltmeters for use with instrument transformers. Generally speaking full-scale values of ammeters are required either to correspond with the rated primary current of the c.t. or be 33⅓ or 50% above it. Thus for a rated primary current of 100 amps, the full-scale value of the ammeter is 100 or 150 amps, and for 300 amps primary current, 300 or 400 amps is the preferred full-scale value.

# PROBLEMS AND PRACTICE

## In Engineering

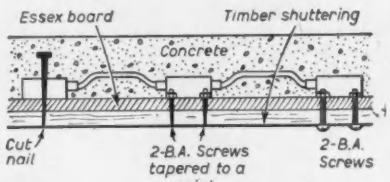
*Every engineer has a story to tell; why not tell yours on this page? We welcome contributions to this feature, and those published will be paid for at our standard rates. Problems which are encountered and overcome in day-to-day maintenance or installation of electrical plant; useful methods and techniques developed for specific jobs, or current practices, all make instructive reading for others. We will also consider for publication problems requiring an answer. Sketches are often helpful and need only be rough, as they will be redrawn before use.*

### Fixing Conduit

AN installation that I carried out at a local dairy included nine lighting points, to be concealed in a concrete roof. This was straightforward enough but for the laying of "Essex" boarding on the timber shuttering on which the concrete was to be poured, so that, when the shuttering was struck, the "Essex" boarding would remain adhered to the underside of the concrete, thus providing a finished ceiling surface.

The difficulty, of course, lay in fixing the conduit and boxes so that they would not move while the concrete was being poured. The normal method of driving nails into the shuttering on either side of conduit close to the bones and breaking them off after the shuttering is struck, could not be used, as this would have disfigured the underside of the "Essex" board.

The concreting being scheduled to commence on the following day, a quick decision was necessary. The method I adopted was to drill a hole in the top of each conduit box and drive a cut nail down through the "Essex" board into the




*Here are shown three possible methods of fixing conduit to shuttering where "Essex" board intervenes*

timber shuttering. When the latter was struck, I was able to work the nail to and fro until it broke off almost flush with the top of the box. This method, admittedly rather crude, proved very effective and having given the problem much consideration since, I have been unable to arrive at any more conventional alternative. Perhaps other readers have run into and overcome this difficulty in other ways.

Two other methods have occurred to the writer, although no opportunity has arisen to try them out. One involves the manufacture of 2 B.A. threaded tapered pins, which are screwed into the lugs of the box. The box would be then tapped gently down until the tapered pins have been driven through the "Essex" board into the shuttering. In the other method ¼ in. holes are drilled through the "Essex" board and shuttering, the box being fixed down from the underside with 2 B.A. screws. These would have to be removed before the shuttering were struck. This method could not be used, of course, where any obstruction existed on the underside of the shuttering, as in the case of shuttering supports.—*W. Satchwill.*

### "Live" Water

A FEW days ago I was called to an interesting fault which had developed indirectly as a result of the recent freeze up. A number of consumers in a block of two storey flats complained of shocks from the cold water taps. It was ascertained that the shocks were felt intermittently and only by some consumers. An earth loop tester was used to check the resistance of the water pipe, and it was found that some pipes were in the region of approximately 1 ohm, while other pipes were in the region of several megohms. Then it was discovered that the local Water Board had been carrying out repairs and it was found that one section had been completely isolated from the main, due to the number of bursts, until the repairs could be completed. This was the section which gave rise to shocks.

It was now evident that a faulty appliance was in one of the flats, so a voltmeter was connected between the water pipe and neutral while one man switched on various appliances in each flat. At one point the meter registered 80 volts thus localising the faulty appliance, which proved to be a radio set. This was a new receiver and suspecting a faulty transformer or condenser these were tested and found to be in good order. However, in the course of tests a strange phenomenon was noticed. When the set was switched on the voltage across the current pins of the socket dropped from 230 volts to 150 volts while the voltage between the live and earth pins remained at 230 volts. It was apparent then what had happened. The electrician (?) when installing the socket, had connected the neutral to the earth socket and the earth to the neutral socket. This was confirmed by disconnecting the neutral at the service board, and the set remained "on."

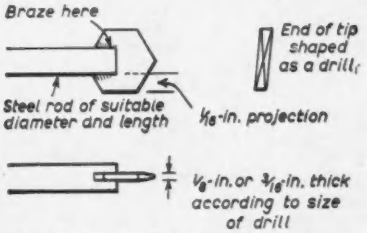
Thus, when the set was switched on the circuit was completed via the semi-isolated water main. Had an electric fire or similar heavy current consuming appliance been used the results could have been serious.

I should add that this point was installed by a "friend of the father's uncle" who had "passed out" as an "electrician." The Electricity Board had not been notified and therefore no test had been made. Incidentally while inspecting the various premises a frightening state of affairs was observed such as earth wires merely wrapped around pipes or left off altogether, odd lights wired in flex and in one case with bellwire (of all things) in the bathroom!—*W. T. W.*

### A Tip for Tools

BY the conventional method, plugging brick and concrete walls can be arduous work, but a method I have found overcomes this effort and is in many ways superior to the hammer and chisel method. In engineering hardened tool tips are put to many uses—lathe cutting, mine stone drilling and the like—and these tips (either ¼ in. or 3/16 in. thick as required) either purchased from the appropriate retailers. It may also be possible to utilise broken tips which were originally designed for some other purpose.

Having obtained the required tips they have then to be shaped by judicious grinding to the form shown in the accompanying sketch. The tip has then been inserted in a slot cut in the end of a length of steel rod of a suitable diameter and brazed in position. The tool can be used in a brace or portable drilling machine. Cutting into a wall takes no time at all, and if the steel bar is long enough it is a simple matter to bore right through. Tiles or glass may be drilled


Braze here
End of tip shaped as a drill
Steel rod of suitable diameter and length
⅛-in. projection
¼
⅛-in. or 3/16-in. thick according to size of drill

*This sketch illustrates the method of fixing the tip to obtain a masonry boring tool*

without fracturing the material—in fact, once part of the tool bag these tools will come to be regarded as an indispensable item.—*G. A. L.*

*(Readers may like to know that "Durium" tipped drills—similar in purpose to those described above—are produced commercially by Rawlplug Ltd.—Ed.)*

# *Equipment for Industry*

## Motorised Die-head

THREAD cutting forms a large part of installation work involving conduit, and hence any means which reduces time spent on this work will be reflected in a reduction of labour costs. To this end, the "REMS-Electromat" portable motorised chaser type die head, available from WM. URQUHART, 1023 Garratt Lane, S.W.17, should prove a useful instrument. Used in conjunction with a standard tripod and conduit vice, the "Electromat" may be operated by one man at almost any site. A useful feature is that it may be operated by hand as an ordinary die-stock should no supply be available.

The revolving die head holds four chasers and is powered by a 220/230 volt universal type floor motor which is coupled to the head by a flexible drive. To operate the unit, the die is adjusted to the required thread diameter by means of coarse and fine scales on the head and then placed square on the pipe or bolt end. The motor is then switched on, the switch being built into the handle for convenience, and the unit proceeds to cut in the ordinary way. Normally the operator will guide the machine by hand, but, if necessary, it can run automatically, a limit switch operating after the required length of thread has been cut. On manual control, when the limit is reached, the operator opens the jaws by turning a twist-grip control through 90° and the motor then switches off. On resetting the jaw-opening control the chasers resume their original diameter. Standard equipment provided with the "Electromat" include chasers and holders for right hand threads, and gauge and key, whilst l.h. thread chasers and holders are supplied as extras.

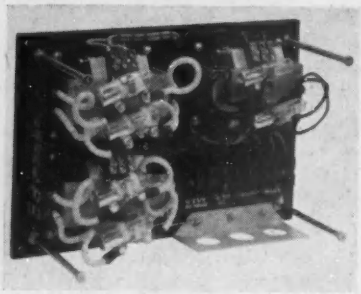
## "Bicaloy Electrode Tips"

READERS may be interested to know that although the manufacture of their resistance welding and heating machines was recently taken over by the Metropolitan-Vickers Electrical Co., Ltd., BRITISH INSULATED CALLENDER'S CABLES LTD. continue to produce and supply "Bicaloy" electrode welding tips.

## Mains Failure Unit

ORIGINALLY designed for use with diesel driven alternator sets, transferring the load to the auxiliary supply, a mains failure unit produced by ENGEL AND GIBBS, LTD., Warwick Rd, Boreham Wood, Herts, has a particular value for use in schemes in which the generating plant is required to be started up only when a load is switched on. As the unit itself makes use of the battery source to energise the auxiliary supply transfer relay, no load is imposed on the auxiliary supply and hence false starting on mains failure is prevented. By rearrangement of wiring and coils, the unit may also be employed to switch on a second static source of supply.

Three relays are used, all of the mercury contact type. Normally the public supply is connected to the load through heavy current d.p. contacts in the mains relay, its operating coil being energised from the mains through one of the two contacts of the timing relay. The coil of the timing relay is also energised from



*Engel and Gibbs' mains failure unit with cover removed. The two d.p. load current carrying relay contacts are seen on the left*

the mains supply, so that on failure the contact is opened thus open-circuiting the mains relay coil circuit and breaking the contacts. After a two second delay, the second contact on the timing relay then closes, completing a 24 volt battery circuit to energise the auxiliary relay and thus connect the load to the auxiliary supply. The low voltage circuit may also control the diesel starter motor, which will then be energised to start the auxiliary supply. Where a permanent auxiliary or secondary supply is available, the auxiliary relay may be energised from it provided a relay coil of the correct voltage is used.

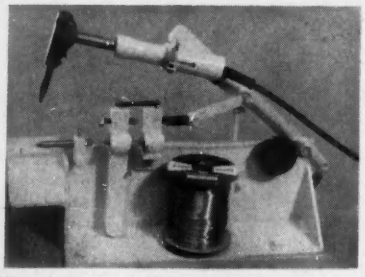
## The "Stellar" Filter

ONE of the latest developments in filtration is seen in the "Stellar" filter, now being manufactured by the PATERSON ENGINEERING CO., LTD., Windsor House, Kingsway, W.C.2. Representing a departure from the sand filter and other conventional types, the "Stellar" employs a powder bed of either kieselguhr or diatomaceous earth, thus obtaining filtration rates stated to be considerably in excess of those obtained with other media of comparable compacity. Since no coagulant is required, considerable saving in operation costs are effected whilst permitting its use for filtering liquids where the addition of chemical coagulants is not permitted. One possible use is seen in filtering transformer oil which has been contaminated with sludge and moisture, the original dielectric strength, it is claimed, being restored.

Basically, the filter comprises a specially constructed element formed by a wire wound in a screw thread over a rigid foundation. On this unchokable strainer the filter bed of kieselguhr is deposited, the grade of medium determining the degree of filtration. Depending on the liquid to be filtered the shell is constructed in steel or other metals, an observation port in the body providing means of observing the formation of the filter bed on the elements. Standard construction consists of a mild steel shell, gunmetal valves, elements in extruded brass which is electro-tinned after manufacture and then wound with "Monel" wire. For liquids other than water, stainless steel or some other metal is provided for these components.

## Automatic Soldering

SPECIFICALLY designed for use in repetition soldering processes of small components, the automatic soldering machine recently introduced by MULTICORE SOLDERS LTD., Maylands Avenue, Hemel Hempstead, Herts, is available in three models, one of which is a motorised version claimed to be capable of making joints at a rate of up to 3,000/hr. As seen in the accompanying illustration, the unit incorporates a reel of solder from which the solder is fed automatically above the parts to be soldered. An electrically heated iron then descends to perform the soldering operation. In the standard equipment, the iron has a long-life 80 watt element and a minimum temperature of 300° C at the end of a 2 in. long, $\frac{1}{8}$ in. dia. bit whose



*This shows the Multicore soldering machine which is designed for repetition work*

length is adjustable. Other size bits and irons can be supplied to order. Solder of any diameter from 13 to 19 s.w.g. may be used, the feed length for each operation being variable between 7/32 and $\frac{7}{8}$ in. Apart from the motorised model mentioned earlier, there is a version without motive power of any kind to enable its incorporation in an existing manufacturing process, and another supplied complete with a bench and foot-operating pedal.

## New Metrovick Fitting

A NEW industrial fitting is now available, accommodating two or three of the 8 ft 125 W fluorescent lamps which are increasing in popularity on account of their high efficiency (5,000 lumens throughout life) and their excellent "natural" colour rendering. They provide good light penetration and high values of vertical illumination.

This new fitting, introduced by METROPOLITAN-VICKERS ELECTRICAL CO., LTD., 1-3 St. Paul's Churchyard, E.C.4, is a bonderised sheet steel trough stove enamelled white and built in two halves for easy stocking and transportation. These halves are joined together in assembly by cast aluminium straps. The standard unit is slotted along the top of the reflector and auxiliary gear is mounted on a heavy gauge metal tray placed just above the reflector. Turret type b.c. lampholders fitted are moulded in white plastic and are a new development adding to ease of maintenance. The fitting is complete with transformers and capacitors for instant start operation ready wired.

*A new fitting for 8 ft. fluorescent tubes*

## Kenwood "Steam-o-Matic" Price

THE price of the new "Steam-o-Matic" steam or dry iron introduced by KENWOOD ELECTRICS LTD., 26 North Audley St, London, W.1, has now been announced. The iron will sell at £4. 12s. 6d.

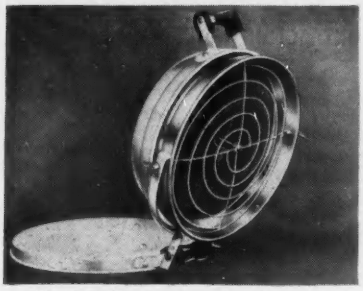
## Perihel's New Deep Ray

THE development of a new infra red health lamp is announced by PERIHEL LTD., Edge St, W.8.

To be marketed under the name "Deep Ray," the model has a number of novel features. First the company emphasise the wide radiation of the unit and point out that the output is sufficient for full body treatment; secondly the emission is of the long wave type of which very little is absorbed on the skin.

The element is completely cemented and protected by a wire guard so that the "Deep Ray" is a safe unit. It is also a very compact unit, dust free, stable on its solid base and easy to handle.

The "Deep Ray" is guaranteed for twelve months and is sold against a medical prescription. The price is £5. 5s.



*The Deep Ray is compact and portable*

## "Buttador" in Hotpoint H.30 Frig

FOLLOWING on our announcement of new 1954 models in the "Coldrator range of refrigerators, THE HOTPOINT ELECTRIC APPLIANCE CO., LTD., Fletton, Peterborough, now announce improvements to their H.30 domestic refrigerator. These include the addition of the "Buttador" (see page 329, 4 Mar.) and the incorporation of moulded nylon hinges, the lower of which being so designed to accommodate the special tinsel core cable connecting the heating element of the "Buttador" to the intake terminals of the motor starting relay. Features of this model (4½ cu ft capacity) are a large stainless steel freezer with plastic door; a chillerdish; two 20 cube aluminium ice trays; 8·3 sq ft of shelf area (two steel wire and one plate glass shelves) and an armoured plate glass table top. Price is £99 5s. 2d. tax paid.

## "Cupola" Spotlights

MAZDA "Cupola" fittings are now available for use with 75 and 150 W reflector spotlight lamps announce the BRITISH THOMSON-HOUSTON CO., LTD., Crown House, Aldwych, W.C.2.

These fittings provide an inexpensive adjustable housing which may be mounted on any plane and trained through a cone with an angle of 38°. They consist of a spun aluminium housing stove enamelled dove grey and mounted on swivel brass lampholders. Overall lengths of the two fittings are approximately 10¼ in. and 12 in.

Prices are as follows: For 75 W lamp 27s. 6d.; for 150 W 30s. Brass swivel holders can be supplied without housings. These are priced 13s. for the b.c. lampholders (75 W) and 15s. for the e.s. holder.

## Sunvic's Low Price Thermostat

TO meet a demand for a simple immersion type thermostat, which, set to a predetermined temperature, may be removed without having to drain the hot water system, SUNVIC CONTROLS LTD., 10 Essex St, Strand, W.C.2, are introducing a new water heater thermostat this week. Known as the type TQB, and priced at the low figure of 15s. 3d., this compact unit is only 7 in. long and is designed to fit into a pocket of nominal internal diameter of ¾ in. Supplied at one of three possible settings, 140° F, 160° F or 180° F, the unit achieves compactness of design by utilising a simple bi-metal strip to operate a snap-action switch. Modification of the setting may be made by an adjusting screw.

## Mk II Version Fisher "Autowasher"

A NEW Mk II version of the Autowasher Type "L" has now been released by H. FISHER (OLDHAM) LTD., Oldham, Lancs. The height of this model is now 34 in. giving with the aid of the wringer an additional advantage of "sink wringing and rinsing." Extra flexible cable has also been provided to permit greater manoeuvrability.

As from 1 Mar. the firm's Autowasher type "L" will incorporate these improvements and new prices will operate. The a.c. model will cost 42 guineas plus £16. 10s. 9d. tax, a total of £60. 12s. 9d., and the d.c. model will cost 47½ guineas plus £18. 14s. 1d. tax, a total of £68. 11s. 7d. All orders placed before 1 Mar. will still be executed for the original type "L" at the previous price of £39. 18s. plus purchase tax £14. 19s. 3d. subject to discount.

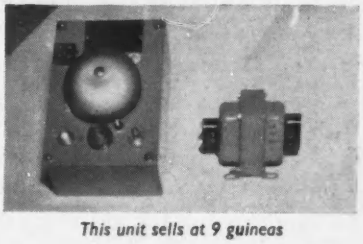
*For the Electrical Trade*

## Main Failure Alarm

THE growing use of infra-red lamps and other appliances in the rearing of pigs and poultry has brought about a demand for an efficient warning of a mains failure or breakdown.

Such an alarm system has been developed by an Essex firm of electrical contractors, GEO WHITE AND SONS, of Fyfield, Ongar. This all-purpose alarm comprises two units, the first an alarm unit which is fitted in any convenient position, and the transformer unit which is connected to the electricity supply in the brooder house or piggery. The two units are interconnected. When all is well the unit shows a small pilot light.

This White All-Purpose alarm sells at £9. 9s. and is distributed through the normal trade channels.



*This unit sells at 9 guineas*

# NEWS OF THE WEEK

## Deadlock After 2d. an Hour Award

### N.F.E.A. OFFER ACCEPTED BUT E.T.U. PRESSING FOR MORE

AN INCREASE in wages of 2d. an hour for journeymen electricians, with proportionate rises for adult mates and apprentices in the contracting industry, has been granted by the National Federated Electrical Association, with effect from Monday, 15 Mar. The new rates of pay are set out in the accompanying tables. In announcing the increase, the N.F.E.A. agreed to a meeting of the N.J.I.C. being held last Friday at which the Electrical Trades Union pursued their wages claim. With the announcement of the increase in pay, strikers called out by the E.T.U. returned to work last Thursday. In its statement, the N.F.E.A. explained that all relevant factors, including the cost of living upon which basis the E.T.U. submitted its claim for a wages increase, had been under continual review. The award has been made in the light of the Report of the Court of Inquiry concerning the Engineering Industry, and whilst it was clear that its conclusions and recommendations were confined to the Engineering Industry, the N.F.E.A. recognised their relevance to other industries.

At the N.J.I.C. meeting last Friday the E.T.U. continued its claim for a "substantial increase" in pay for the electricians. Further discussions took place on Monday but came to a halt after the union refused to allow the N.F.E.A. any more time to consult its members concerning the wage claim. When the union officials moved that there should be a further increase above the 2d. an hour, the N.F.E.A. representatives refused to vote on the motion.

The original application for a substantial increase in wages was made by the E.T.U. about a year ago, and rejected in June by the N.F.E.A. A series of "guerilla" strikes began last August, continuing until mid-September when a court of inquiry was appointed. After their report negotiations were resumed only to collapse finally on 6 Jan. after the association had offered 1½d. an hour, with certain geographical exceptions, but with a reduction in overtime rates.

In Scotland, the E.C.A. of Scotland has also agreed to an increase of 2d. per hour on the standard craftsman's rates as from 15 Mar., with proportionate rises for apprentices.

| Journeymen | s. d. | Adult mates | s. d. |
|---|---|---|---|
| Grade "A" | 4 2 | London ... | 3 5¾ |
| | | Bristol ... | 3 1¾ |
| Mersey district | 3 10 | Mersey ... | 3 0¾ |
| Grade "B" | 3 9 | Elsewhere | 3 0 |

### Pollution Injunction Suspended to October

THE injunction granted in 1952 against the B.E.A. relating to pollution of the River Derwent by hot cooling water from Spondon power station, was further suspended until next October by Mr Justice Harman, in the Chancery Division last Thursday. Injunctions against Derby Corporation and British Celanese Ltd. were further suspended until December 1955. For the B.E.A. Mr Henry Salt, Q.C., said works costing £110,000 were being carried out to reduce the volume and heat of water discharged from the power station; but the scheme could not come into operation this summer although they were advised that they would be able to obey the injunction by next October. Granting the extension, his lordship said he thought the B.E.A. would not have embarked upon such a large expenditure unless they were well advised that it would have the desired effect of preventing pollution.

### LONE ELECTRICAL FIRM IN TALKS WITH CHINA

DESPITE the cancellation of the trade visit to East Berlin by some 26 British businessmen for trade talks with China, one man is still travelling to the German capital. He is Mr G. J. Willsmer, of Crompton Parkinson Ltd. He goes at the direct invitation of the China National Import and Export Corporation in Berlin (the purchasing organisation for the Peking Government) and is in no way connected with the China Trade Committee or with arrangements already mentioned. The Committee was formed to represent the U.K. party which visited Peking last summer under the auspices of the British Council for the Promotion of International Trade. The company sent a representative to Peking, but following the Foreign Secretary's denunciation of the Council last November, Crompton Parkinson resigned from that body and subsequently from the China Trade Committee.

### *London's Spring Course on Illumination*

A SUMMARY of the programme drawn up for E.L.M.A.'s Spring Illumination Design Course in London was made known last week. It will extend over four days opening on 27 Apr., and as usual will take place at the Lighting Service Bureau at 2 Savoy Hill. In the main, the course follows the familiar pattern. The first day forms an introduction with talks on Lighting in the National Economy, on Light and Lighting Terms, and on Vision, Brightness and Colour. The second day is devoted to the various types of lamps and to design, with a short explanation of E.L.M.A. separating the two. The whole of Thursday and much of Friday is taken up with applications of lighting, dealing (in order) with shops, schools, industry, floodlighting, street-lighting, sport, hospitals, offices and homes. Final talks will be on Built-in Lighting and the Progressive Idea. Early application for seats is advised once again, and should be made to Mr E. B. Sawyer, manager of the Bureau. The organisers ask that reservations be made for the entire course rather than for particular lectures, because the course is arranged as a whole and reservations for parts of the course tend to eliminate others wishing to attend.

### NEW WAGE RATES FOR CONTRACTING INDUSTRY

| | Males under 21 years Category II | | | Apprenticeship scheme Category I and II | | | Category III | | |
|---|---|---|---|---|---|---|---|---|---|
| Age | Grades A | Grades B | Mersey dist. | Grades A | Grades B | Mersey dist. | Grades A | Grades B | Mersey dist. |
| | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. |
| 15 | — | — | — | 8 | 7½ | 7½ | — | — | — |
| 16 | 10½ | 9½ | 10 | 9½ | 8¾ | 9 | 1 1½ | 1 0 | 1 0¼ |
| 17 | 1 1½ | 1 0 | 1 0¼ | 1 0 | 11 | 11¼ | 1 5½ | 1 3½ | 1 4 |
| 18 | 1 6½ | 1 4½ | 1 5 | 1 5 | 1 3½ | 1 4 | 1 10½ | 1 8½ | 1 8½ |
| 19 | 2 0½ | 1 10½ | 1 10½ | 1 10½ | 1 8½ | 1 8¾ | 2 4½ | 2 1¾ | 2 2¼ |
| 20 | 2 6½ | 2 3½ | 2 4½ | 2 6½ | 2 3½ | 2 4½ | 2 10¾ | 2 7½ | 2 8 |

## *Vital Factors in the Export Business*

IN THE ever-present and important matter of increasing exports from this country, we are constantly on the look-out for hints and advice, especially for the small firms with limited facilities for overseas representation, which may be of assistance. At the Conference for Small Firms held at Ashorne Hill, Leamington, earlier this month, Mr J. R. Davis, chairman and managing director of Suntex Safety Glass Industries Ltd., read a paper on Export Marketing, giving some useful hints gained from that company's experiences abroad.

Dealing with the subject chronologically, Mr Davis first referred to preliminary research. An initial survey and study of the market was indispensable. The intending exporter should discover whether the product was suitable for the market chosen and whether he should develop a number of smaller markets collectively or concentrate on one market with a much more probable return. Initial research often saved time and money later. Detailed planning of a campaign to the last item was essential, and Mr Davis emphasised the need for personal visits to the territory. Exporting by "remote control" was seldom successful, and the buyer invariably wanted to see both the product and the seller.

From the production and distribution of sales literature, Mr Davis went on to recommend the writing of letters and quotations in the buyer's language. The customer was unlikely to bother with translations if he could easily read another manufacturer's communication. One of the greatest problems concerned credit terms. Long term credits had little appeal but if they were ignored, business would be lost. He added that he doubted the wisdom of extending credit generally and the answer probably lay in both price structure and delivery.

Other points included prices and delivery. British firms should explore every avenue to reduce production costs, and concentrate particularly on the vital need to maintain rapid delivery schedules. The extension of sales, particularly in America, depended to a large extent on rapid delivery service. One false step in this direction gives competitors the one opportunity they need.

## NEW EXHIBITION ON REFRIGERATION

THERE is not a lot of breathing space allowed between exhibitions at the Midlands Electricity Board's industrial showrooms in Chester St, Birmingham. The next exhibition opens on Monday next and will feature Industrial and Commercial Refrigeration Equipment. It will remain open to all interested consumers until 2 Apr. between 10 a.m. and 12 noon, and 2 p.m. to 5 p.m. on weekdays. Exhibits include industrial low temperature cabinets, quick freezing cabinets, ice cream conservators, frozen food showcases, bottle coolers, 100 cu ft cold room, florists' display cabinets, dual temperature counter, blower coils and condensing units and similar apparatus.

## Electrical Industry gathers at Earls Court

BY THE time this is read many in the electrical industry will have visited the third Electrical Engineers' Exhibition which opened at Earls Court, London, on Tuesday. With a total of 179 stands, this year's display is nearly double the size of that impressive and highly successful show in 1953, which in turn far surpassed the 1952 exhibition in the much smaller Horticultural Hall. Official attendance figure last year was 14,250, but with the extra day this time, not to mention the ever-increasing interest, that figure is certain to be far surpassed. On Tuesday, the opening day, the attendance was in excess of 4,000, we understand.

## Electrical Research in Glasgow in 1952-53

INVESTIGATIONS into arc control devices and contact phenomena in air-breakers are part of the current research programme at the Royal Technical College, Glasgow. This is stated in the recently issued "Report on Research, Session 1952-53." The Electrical Department is now equipped for work with sustained currents of some hundreds of amp a.c. or d.c., and with currents of up to 3,000 amps for a duration of several cycles. Other work concerns the application of oscillographic apparatus to power system studies and into spark phenomena. In connection with the latter work, there is an investigation of the criteria for power current to follow through an impulse flashover.

## Canadian Trade Fair Opens on 31 May

THE seventh Canadian International Trade Fair is to be held in the Exhibition Grounds at Toronto from 31 May to 11 June. As in previous years it is being organised by the Exhibition Commission of the Canadian Department of Trade and Commerce. Most manufacturers will be well aware of this important event, but this reminder may not be considered out of place when it is remembered that this show is the only International Trade Fair held regularly in North America at the present time. As such, of course, it offers unique opportunities to British manufacturers to present their goods to both Canadian and U.S. buyers. Those interested should either ask their agents to contact the Administrator, Canadian International Trade Fair, Exhibition Park, Toronto 2B, or write themselves to the London representative, Miss M. A. Armstrong, Canadian Government Exhibition Commission, Canada House, Trafalgar Sq, S.W.1.

## Increased Importance of Cyprus Trade Fair

DURING the last seven years, Cyprus has almost trebled her overseas trade until in 1953 her imports amounted to some £20 million. Goods from the U.K. accounted for almost half this figure, and consequently the fifth Cyprus Trade and Industries Fair, to be held from 17 July to 16 Aug. at Nicosia, is not one to be ignored. The Fair this year will be the largest ever held on the island, and favoured geographically with good air and shipping facilities, it is fast establishing itself as a centre for Middle East business activities. Applications for space should be sent to the Organising Committee, 8 Vassilios Voulgaroctonos St, Nicosia, Cyprus (P.O. Box 625). Charges are £2 per sq metre for open space for private pavilion and £9 per sq metre for special space within a pavilion. Incidentally electrical goods are among the U.K.'s principal exports to Cyprus.

## German Exhibitions of Electrical Goods

WESTERN Germany is again offering her goods at five Fairs, closely co-ordinated in both time and place, this year. They are at Frankfort, Hanover, Cologne, Nuremberg and Offenbach, all within easy reach of one another. The Toys Trade Fair at Nuremberg and the Offenbach Leather Goods Fair are of passing interest. Not so the others, however, where there are good ranges of electrical commodities.

At Frankfort the Spring display took place last week and the autumn repeat will be held between 5 and 9 Sept. Electrical goods form a very prominent part of the exhibition. No less important is the German Industries Fair at Hanover where the combined display of heavy and light industries takes place between 25 April and 4 May. For the first time, the radio industry will show its products as a self-contained group. Of a more domestic nature the International Cologne Fair which also has two sessions and some subsections. The autumn household goods and hardware fair will take place from 5 to 7 Sept.

## —OFFICIAL PUBLICATIONS—

NATIONAL BUILDING STUDIES. Special report No. 22: Fire Hazards of Internal Linings. H.M.S.O. 1s. 3d.

BRITISH STANDARD.—C.P.1005: Code of Practice on Use of Electronic Valves, Parts 1 and 2. B.S.89, 1954: Electrical Indicating Instruments.

COMPETITION BETWEEN STEEL AND ALUMINIUM. Available from H.M.S.O. 9s. (see page 400).

*Indirect lighting from a central laylight housing pink tungsten lamps with cold cathode tubes in the cornice, in the ballroom of Glasgow's new NAAFI Club. Right is the Tavern showing specially designed fittings to blend with the architecture*

## Variety of Lighting Techniques at Services' Club

ILLUMINATION of Scotland's first permanent N.A.A.F.I. Club in Glasgow is remarkable for the variety of applications and techniques of lighting employed. The club occupies three floors of an eight-storey building at the junction of Buchanan and Sauchiehall Streets.

The lounge resembles a liner's first-class lounge, and to enhance the polished mahogany wall panelling, satin silver pendants with champagne glasses were chosen for lighting. Wall brackets are mounted at the sides of the fireplace. Similar pendant fittings were used in the writing alcove and music room. Turning to the restaurant, the decoration comprised Jacobean dark-oak panelling and light-oak upholstery. To suit this eleven octagon fittings in armour bright finish with glazed hammered glass panels were used. Each houses eight 40-60 W lamps.

Another idea was required for the tavern, designed to resemble a Scottish baronial hall with dressed stone walls and open fireplace. Fittings were specially designed for this room and consist of four lanterns suspended on iron scroll work with a thistle motif. A more modern design is to be found in the ballroom with its blue leather cloth and silver grey curtains. A suspended ceiling hides an indirect lighting installation and a central laylight houses pink tungsten lamps with dimmer control. There is a three-colour cold cathode fluorescent installation also with dimmer control in the cornice. Finally, on the main stairway a portrait of H.M. the Queen is cunningly lit by a spotlight hidden in a staircase fitting. The latter is an 8-light pendant finished in satin silver and brushed copper with champagne glasses. Architects for the club were Messrs Reid and Forbes of Edinburgh, and all lamps and fittings were supplied by the G.E.C.

## New District H.Q.

A NEW headquarters for the N. Western District of Birmingham was officially opened by Mr W. S. Lewis, chairman of the Midlands Electricity Board on Monday. It is situated at 23-25 Constitution Hill. Mr R. Eckersley, the district manager, who was previously in temporary premises in Chester St, said it was hoped to operate more economically and efficiently. In addition, consumers would find the new service centre more easily accessible. Major tasks which this office has in hand at present are the installation at Gosta Green's Central Technical College and the changeover of some 7,000 consumers from d.c. to a.c.

## 1954 Golf Championships Return to London Area

THIS year's E.I.B.A. National Golf Championships, open to all in the electrical industry, is to be held at the Moor Park Golf Club, Northwood, Middx, on 4 Oct., we are informed by the national secretary, Mr. F. H. Farthing. Facilities provided at Moor Park include two courses so that all the events associated with these championships will be played off on the one day instead of the two normally required. The annual dinner always associated with the fixture is to take place at the Park Lane Hotel, London. We understand also that two changes have been necessitated on the national committee. Messrs J. S. Foggett of English Electric, and W. A. Ankerson of A.E.I., take over from Messrs J. A. Fraser and H. Boyd-Brown.

Area finals are now being organised and the first date to come to hand is 1 July when the London area finals will be played at the Berkshire Golf Club.

### A.S.E.E. ANNUAL DINNER

SOME tickets are still available for the A.S.E.E.'s annual dinner and reunion which is to be held at the Connaught Rooms, W.C.2, on 2 Apr. The Association's general secretary, Mr E. A. Bromfield, advises early application. Sir Miles Thomas, chairman of B.O.A.C., is among the principal speakers at this function.

## BULK SUPPLY TARIFF CRITICISED AS UNSOUND

THE Eastern Electricity Board has given an assurance that despite heavy increases in costs it was not proposed to make any increase in the general tariffs this year. Passing this information on to the Consultative Council at their recent meeting, Ald W. J. Bennett, chairman, commented on the disastrous effect the cold spell had had on the Board's finances. It had increased the maximum demand by 120,000 kW and as a result of course the Central Authority had to be paid on that basis. The majority of industrial consumers, he said, paid the maximum on a monthly basis only, and that fact had cost the Board about £500,000. Ald Bennett said this demonstrated the inherent weakness of the bulk supply tariff.

Later the chairman said standard tariffs in the Area were under review. Certain changes were likely to be announced following the next Board meeting. These will be generally advantageous to consumers, we understand.

## The First Half-Century

The Glasgow section of the I.E.E. considered the subject of coal cutting machinery on a short paper by Mr Sam Mavor. A coal cutting machine worked with compressed air was first invented by a Newcastle man in the middle of the last century, but the adoption of machine cutting here had been very limited. In America development of machine mining had been more rapid, and in that country there were over 3,000 coal cutting machines at work as against about the same number of hundreds of coal cutters in Britain. In fact in America about 25% of the coal output was mechanically cut, and in Britain only about 2 to 3%. The three best known types of coal cutting machines are the disc, the chain and the bar type. The last was that which Mr Mavor favoured.

*—From our issue of 17 Mar, 1904.*

## Deputy Lord Mayor makes Three Suggestions

REDUCTION in the price of electricity, education of consumers to observe more effective safety measures, and the publication of simpler tariff lists, were suggestions put forward by Mr C. H. Sutton, deputy Lord Mayor of Norwich, at the annual dinner and dance organised by the Norfolk Electrical Social Committee. Mr Sutton maintained that there ought to be a cheaper method of producing electricity than at present and instanced the heating of Norwich City Hall where after 17 years it had been found cheaper to heat by oil instead of electricity. Too many people were trying to do their own electrical repairs, he said, leading to accidents. It should be possible to devise a more simplified list of tariffs explaining why it was necessary to pay more or less, and easily understood, Mr Sutton said. There were over 300 members and their wives present at the function. It was the first time ladies had been invited.

## Electrical Education

A.C. IMPEDANCE - TYPE network analysers are discussed at some length in the current number of the *Bulletin of Electrical Engineering Education*, where it is argued that such analysers should be considered in both degree and post-H.N.C. courses. As usual, there are many brief supporting articles, including a treatment of the theory of the ideal repulsion motor in terms of vector loci. Copies of the Bulletin are obtainable from Professor Eric Bradshaw, College of Technology, Manchester 1.

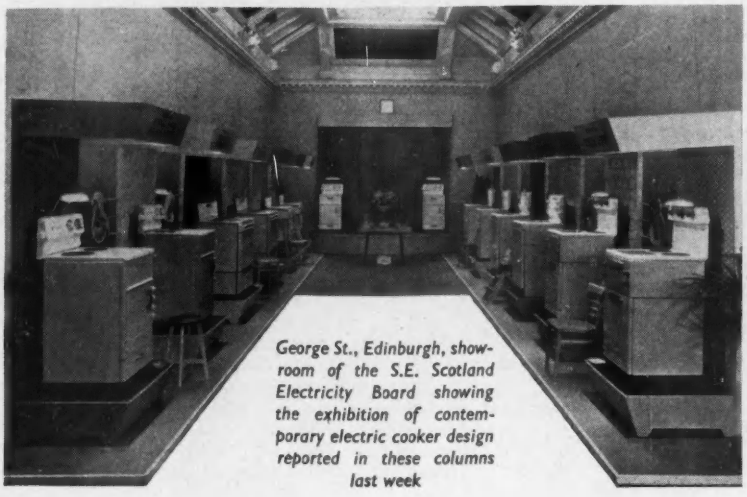
## St. George's Hall Lighting

IN our report of the lighting installation in St. George's Hall, Bradford, in 4 Mar. issue, we much regret that we were misinformed concerning the name of the contractors responsible. In fact the contractors were Roberts and Jowett Ltd., of 283 Legrams Lane Lidget, Green, Bradford, and not as stated.

*A new lighting showroom in central London is now open at the Newman Street, W.1 head office of Arnold Montrose Ltd. Operating in the past from their Finchley Rd., N.W., premises the firm specialise in antique and period type lighting. This in itself is beautiful and is made more attractive by the tasteful interior decoration. No retail sales will be effected*

## RURAL ELECTRIFICATION SHOULD BE NATIONAL RESPONSIBILITY

INDUSTRIALISTS in and around Liverpool are concerned lest they should have to bear the cost of rural electrification in N. Wales. Their view was put before the Merseyside and N. Wales Consultative Council at their meeting last week. The Board is to be asked to state its policy on the financing of development in rural areas. The Council had before them a resolution (defeated) stating that although not opposed to rural areas being supplied with power, the matter should be a national responsibility. Industry's case was put by Mr W. J. Brizell, who asked who was going to pay initially for the large amount of development entailed. Any costs, such as loan interests and repayment of loans, might increase the cost of power to industrial areas, or if not increase the cost, it might preclude or delay a reduction in charges, so badly needed. The work in N. Wales, he said, ought to be looked upon as a social service and paid for from national funds. We understand that this matter is being seriously considered by the B.E.A.



*George St., Edinburgh, showroom of the S.E. Scotland Electricity Board showing the exhibition of contemporary electric cooker design reported in these columns last week*

## *Lightmonger's Social*

FIRST dinner and social evening of "The Lightmongers" took place in London last Thursday. This society was formed last year and their inaugural meeting was held in November. Object of the society is good fellowship in the lighting industry allied with benevolence towards charitable organisations. Its president is Mr Max Millar, and hon. secretary is Mr V. G. E. Gardner of 92 Normandy Ave, Barnet, Herts.

### Electrical Exhibition

WE wish to make clear that the "Blendolite" industrial lighting fitting, depicted on page 367 of last week's issue, is manufactured by the Edison Swan Electric Co., Ltd. and not by Benjamin Electric Ltd.

## NEWS IN BRIEF

Full details of the Institute of Welding's Spring Meeting, to be held from 28 Apr. to 1 May in S. Wales and Bristol, have been issued.

Sixth annual dinner of the Essex Electricity Sports and Social Club was held at Romford when some 130 members, friends and representatives of manufacturing concerns attended.

Federation of Master Cotton Spinners' Associations, Manchester, has appointed a special technical committee to examine methods of increasing the industry's general efficiency in use of electricity and coal.

The author of the article "Adamjee Jute Mills" which appeared on page 353 of last week's ELECTRICAL TIMES is Mr H. M. Nimmo, and not as stated. Incidentally, the rating of the alternator shown on page 355 should have been given as 1250 kVA.

During the latter part of last week, W. T. Glover and Co., Ltd.'s, dramatic section presented the three-act play "Murder Out of Tune."

The Treasury has made a drawback order which provides for the allowance of drawback of the customs duty paid on certain parts of electrical insulators, when complete insulators incorporating those parts are exported or shipped as stores.

# ELECTRIC SUPPLY NEWS

**Billingham-on-Tees**

THE Urban Council has withdrawn its opposition to the erection of overhead electric cables on housing estates. The North-Eastern Electricity Board has reported to the Council that in the past five years there had been only five cases where overhead lines on housing estates had parted and fallen. In no case, however, had personal injury resulted. The Council had based its opposition to overhead lines on housing estates on the fear that the lines might collapse and cause injury to people living nearby.

**Eire**

THE new Bill (to which we briefly referred last week) empowering the Electricity Supply Board to increase their expenditure on electricity development from £72,975,066, already provided for, to £100 millions, was circulated on Wednesday of last week. Although this Electricity (Supply) (Amendment) Bill limits expenditure to £100 millions, the Board's full programme will add to this another £38 millions. Of the long-term plans of the Board, which extend to the end of 1961, £53,500,000 is required for the Board's general purposes, and £10,500,000 for rural electrification. In addition, a

*Mr Sean F. Lemass, Minister for Industry and Commerce, switching on Eire's 100,000th rural consumer, to which we referred last week. On the right is R. F. Browne, chairman of the Electricity Supply Board*

further sum of £1,750,000 will be required to cover the increased cost of the programme, for which there is already statutory provision. The Bill states that the Board with the consent of the Minister for Finance and the Minister for Industry and Commerce, may borrow money by the creation of stock or other forms of security on such terms and conditions as the Board and the Ministers may determine. The Bill also proposes to transfer the legal ownership of the main Shannon works at Ardnacrusha, Co. Clare, from the Minister for Industry and Commerce to the Electricity Supply Board.

**King's Lynn**

A PROPOSAL by the B.E.A. to erect a generating station at North Lynn was placed before the King's Lynn Town Council last week. The site in mind is on the east bank of the Great Ouse, north of the Coastguard Cottage and extending to the North Lynn Hutment Camp.

**Lichfield**

THE B.E.A. proposes to erect a power station in the Armitage area, it is stated, and the Lichfield R.D.C. has asked the Authority for particulars of their plans to prevent atmospheric pollution.

**Rochdale**

THIS town, at least, feels a little honoured at being selected by the B.E.A. as the site for the proposed main distribution centre for South East Lancashire for the 275 kV grid system—obviously an important role. That is the impression given from a report of the recent meeting when the Council considered the proposal. Outlining this, Alderman Clarke said the northern section of the central circuit had been planned to connect between Penwortham (Preston) and Monk Fryston (Yorkshire) and would pass through the northern part of Rochdale, entering the borough at Red Lumb, and passing north of Wardle and Littleborough. Power would be transformed at the Rochdale main distribution centre from 275 kV and fed into the existing grid at 132 kV. This would involve the construction of a primary substation in the Rochdale area, at a site in Furbarn Lane. From this substation four 132 kV lines were planned to feed into the existing network at Kearsley, Nelson, Chadderton and Rochdale. Ald Clarke said discussions had taken place with the B.E.A. with the object of making the pylons as inconspicuous as possible. The observations of the Lancashire County Council on the routing of the 275 kV line and the siting of the substation had not yet been received but it was not anticipated that any major modification would be requested. The Town Council agreed to the recommendation of the Town Planning and Buildings sub-committee that no major objection be made to the scheme in principle.

## Sayings OF THE WEEK

*"The probability as seen at present is that in four years hence, some 50,000—100,000 kW of electric power will be generated from nuclear fission"* . . . LORD CITRINE in the *Financial Times* survey of the electrical industry.

*"We must become more tolerant of pylons and artificial lochs spoiling our Scottish heritage for the benefits which electricity brings to our country"* . . . HON. MARGARET FORBES-SEMPILL speaking at Aberdeen.

*"Fundamental new ideas in technology, and especially in production of coal and power were needed by this country and the world"* . . . . DR J. M. WHITTAKER, vice-chancellor of Sheffield University, speaking at Sheffield.

**Surrey**

THE South Eastern Electricity Board is to amalgamate its present Croydon and Purley districts in its Croydon and West Kent sub-area. The plan will take over two years to complete, meanwhile the two districts will continue to operate separately under their present district managers. This new Croydon and Purley district will be the largest within the Board's area, serving 117,000 consumers within 71 sq miles. At Electric House, Croydon, the Board has accommodation —left unfinished since 1941 when the Corporation Electricity Department first occupied it—which with a small amount of building work can be used to house the administrative staff necessary to look after Purley consumers. But with a shortage of stores accommodation at Euston Rd, Croydon, the site at Purley previously owned by the County of London Electric Supply Co., can be better utilised. The central meter testing department, garage and domestic appliance renovation department, will remain at Euston Rd, Croydon.

**Yorkshire**

FURTHER changes have now been incorporated in the Yorkshire Electricity Board's revised commercial tariffs. These changes are aimed at meeting earlier criticism from medium consumers, particularly those with offices, places of entertainment, public houses and shops. There is now a choice of either the block tariff for the smaller consumer (based on floor area) or the two-part tariff (based on annual demand charge) for commercial users with a m.d. of 5 to 50 kVA instead of between 20 and 50 kVA as originally proposed. It is judged that these amendments will aid those consumers who, having a large floor space yet small electricity consumption, were faced with a disproportionate increase in charges.

## LIGHTING SCHEMES

**Haslingden.** New lighting for the town's main roads, at a cost of £8,070, is included in schemes for next year.

**Hastings.** The Park and Gardens Committee is to further consider a proposal for a £2,500 profit-sharing illuminations scheme for White Rock Gardens.

**Middlesbrough.** The Corporation Watch and Licensing Committee is seeking the approval of the M.o.T. to improved lighting in Acklam Rd at a cost of £1,610. The Committee has approved a scheme for the provision of 146 lamps on the Park End Estate, to cost £8,000.

**Mitcham.** The Council is considering schemes for electric lighting in Links Rd, Robinson Rd, Lewis Rd and Sherwood Park Rd.

# COMPANY ACTIVITIES

ON a previous occasion I referred to the splendid job of work done by Sir Cyril Entwistle and Mr E. R. Lewis, stockbroker, for the Decca Record Co. Most of the spade work was done during the war years when the group branched out into radar and electronics. It has also specialised in the Decca Navigator for shipping and other purposes.

Even so, the gramophone record business is still a winner despite the competition of radio and T.V. Decca was also a pioneer in the new long-playing microgroove records. Tremendous sums must have been spent on research and development, the rewards for which are now beginning to come in. Turnover has risen from £1,000,000 in 1945/46 to £7,300,000 in 1952/53. So far, main reward for shareholders has been in a tremendous capital appreciation as most of the company's progress has been financed from profits ploughed back into the business. It is quite possible, because of the pioneering work being done, that the distribution policy must for some time remain comparatively restrained.

It would be very interesting to get a sub-division of the group's revenue. In his latest speech, Sir Cyril makes an extended reference to radar activities and other developments apart from gramophone records, but gives no comparative figures.

The full accounts of A.E.I. reveal that the increase in trading profits is due to the policy of returning more and more profits back into the business, which in turn produce more profits.

The total of share capital and reserves have risen by almost two-thirds in the last five years, and ratio of profits has remained at about 22% throughout. How big a part is played by taxation is shown by the report. Total tax charges last year rose by £610,000 to £7,800,000, leaving the distributable balance only £231,000 higher at £2,900,000.

Desoutter Bros. (Holdings), the manufacturers of pneumatic and electrical portable power tools, etc., did well to increase both home and export sales during 1953. For that year was one when the total exports of both electric and portable power tools showed a slight decline, as did home demands. Expanding production has reduced the group backlog of orders and although new orders are increasingly difficult to secure, satisfactory results are anticipated for the current year.

Group trading surplus for 1953 increased by 6% to £404,000. That compared with an increase of 24% in the previous year.

But as the tax charged was £39,000 lower at £254,000 (including £58,000 for E.P.L.) net profits rose by no less than 97% to £128,000. The dividend, increased by 2% to 20%, is covered three times. The company has an excellent working capital position at £787,000 of which £651,000 is in cash, tax certificates and savings bonds. The reserve position could do with a little strengthening as even with £50,000 added this time, total is only £164,000 compared with an equity capital of £350,000.—*From our City Correspondent.*

### Associated Electrical Industries Ltd.

The steady increase in the production of the factories, resulting from post-war capital expenditure on replacements and extensions, has been fully maintained, and a satisfactory increase in the value of export shipments continued in the face of keen competition from abroad, the directors report. From our table it will be seen that progress has been fairly consistent and steady over the past five years.

| Year to Dec. 31 | £ Trading Profit | £ Net Profit* | % on Ord. Earned | % on Ord. Paid | Ord. Price High | Ord. Price Low |
|---|---|---|---|---|---|---|
| 1949 | 7,601,904 | 3,181,426 | 93 | 15 | 80/3 | 68/3 |
| 1950 | 8,439,937 | 3,426,654 | 100 | 20 | 85/9 | 67/9 |
| 1951 | 10,321,225 | 3,872,385 | 112 | 20† | 100/– | 80/9 |
| 1952 | 12,438,300 | 4,051,023 | 86 | 20 | 84/– | 66/– |
| 1953 | 13,674,838 | 4,429,371 | 45 | 15‡ | 45/7 | 36/4 |

*Attributable to A.E.I. Ltd.
†On larger capital.
‡Plus 100% capital bonus.

The full accounts show that the value of stock and materials, work and contracts in progress, were over £700,000 higher at £36,769,846—surely an indication of a further increase in production. An additional £1,377,000 has been set aside for increased replacement costs of fixed assets.

### A. F. Bulgin and Co., Ltd.

The net profit for the year to 31 Jan. last was £29,497, compared with £27,383 for the previous year. The dividend is again 30%. Taxation absorbs only £54,848 this time as against £62,602 for the previous year. The sum of £10,000 is placed to general reserve, and £30,280 is carried forward.

### Burgess Products Ltd.

A meeting is to be held on 5 Apr. to consider resolutions proposing that £100,000 from reserves be capitalised and applied in issuing to holders of Ordinary shares one new Ordinary share for each share held. These new shares will be eligible for any dividends declared on the Ordinary shares in respect of the year ending 31 July next.

### Cambridge Instrument Co., Ltd.

For the year ended 31 Dec. last the profit amounted to £535,719—which is £19,290 more than for the previous twelve months. The final dividend is 2½% making a total of 17½% tax free on the increased capital.

### Ericsson Telephones Ltd.

With a final dividend of 15% the total distribution for 1953 is raised to 25%, tax free, as against 22% previously. The directors also propose a 100% scrip issue. For 1953 the net profit is £460,061, compared with £453,146 for the previous year. The directors state that despite a recession in export trade, a satisfactory level of production was maintained. Although a continuance of present competitive conditions abroad is anticipated provided there is no further deterioration they think it possible to maintain the present position.

### General Engineering Co. (Radcliffe) Ltd.

For the year ended 30 Nov. last, the profit is £44,030 — nearly £11,000 more than for the previous year. The dividend is again 30%.

### A. H. Hunt (Capacitors) Ltd.

The year 1953 was a very active one for this company, and the prospects for the current year are similar, Mr S. H. Brewell, the chairman, reports. A small company in the N.W. of England, specialising in electronic equipment, has been acquired to assist in the design and manufacture of up-to-date test gear. A manufacturing unit has also been established in Canada, where production should commence very shortly. To help meet the cost of the widening of activities an additional £50,000 of working capital was provided last November.

| Year to Dec. 31 | £ Trading Profit | £ Net Profit | % on Ord. Earned | % on Ord. Paid | Ord. Price High | Ord. Price Low |
|---|---|---|---|---|---|---|
| 1949 | 79,377 | 22,599 | 33 | 22½ | 11/1 | 9/6 |
| 1950 | 157,283 | 55,228 | 80 | 25 | 11/10 | 9/5 |
| 1951 | 195,015 | 60,091 | 79 | 25 | 13/9 | 11/7 |
| 1952 | 158,041 | 40,606 | 53 | 25 | 13/1 | 10/9 |
| 1953 | 167,207 | 46,318 | 53 | 25 | 13/10 | 11/9 |

### International Combustion (Holdings) Ltd.

The higher trading profit for the year ended 30 Sept. last reflects the increased business, Mr G. R. T. Taylor, the chairman, states that the output of the group must of necessity continue to increase in order to keep pace with the company's programme and maintain the delivery requirements of customers. A new subsidiary company, International Combustion (Export) Ltd., is being registered, to be responsible for all new export work of the organisation, while another new subsidiary, International Combustion Products Ltd., will take over the activities of the operating company, International Combustion Ltd.

| Year to Sep. 30 | £ Trading Profit | £ Net Profit* | % on Ord. Earned | % on Ord. Paid | Ord. Price High | Ord. Price Low |
|---|---|---|---|---|---|---|
| 1949 | 664,993 | 268,021 | 54 | 21† | 20/6 | 15/9 |
| 1950 | 1,052,970 | 369,118 | 75 | 20 | 17/4 | 14/9 |
| 1951 | 1,366,701 | 536,059 | 115 | 25 | 24/– | 15/9 |
| 1952 | 1,530,260 | 426,581 | 44 | 20‡ | 12/10 | 9/3 |
| 1953 | 1,568,557 | 438,794 | 42 | 20 | 15/6 | 12/1 |

*Available for parent company.
†Plus 150% capital bonus.
‡Plus 100% capital bonus.

### Midland Electric Manufacturing Co.

The reduction in the overall volume of business during 1953 is reflected in the trading results. New products have been introduced and energetic steps taken to reverse the trend, with an intensification of sales promotion in the export markets As a result the volume of incoming orders at the present time is substantially in excess of the corresponding period last year. Mr W. L. Barber, the chairman, reports. Work is now proceeding on the reconstruction and enlarging of the Designs and Research Laboratories with a view to providing improved facilities for development work. The strong financial position of the company is further enhanced by the transfer of £120,000 to general reserve, thus increasing revenue reserves to a total of £595,000. Stock in trade is valued at £377,500 as against £560,200 a year earlier.

| Year to Dec. 31 | £ Trading Profit | £ Net Profit | % on Ord. Earned | % on Ord. Paid | Ord. Price High | Ord. Price Low |
|---|---|---|---|---|---|---|
| 1949 | 287,959 | 117,891 | 46 | 12½* | 8⅝ | 7⅛ |
| 1950 | 328,207 | 129,616 | 51 | 15 | 58/- | 52/9 |
| 1951 | 376,841 | 138,611 | 57 | 15 | 67/- | 56/3 |
| 1952 | 477,092 | 155,811 | 65 | 15 | 60/6 | 52/3 |
| 1953 | 385,611 | 145,088 | 57 | 15 | 58/9 | 58/9 |

*Plus 200% capital bonus.

### Rheostatic Co., Ltd.

There is a final dividend of 12½% on the Ordinary capital which was increased by a 5 for 28 rights issue. This makes a total distribution of 20% for the year ended 30 Sept. last, compared with 19% for the previous year on the smaller capital. The trading profit for the year is £164,160 as against £165,600 for the preceding period, and the net profit £51,152 (*£44,585*).

### Yorkshire Copper Works Ltd.

Scrip issues involving £1,252,344 are proposed. This sum is to be capitalised from reserves, in the form of one 5% £1 Cumulative Second Preference share and one £1 Ordinary for each £1 of Ordinary Stock held. It is also proposed to transfer £200,000 from general revenue reserve to the reserve for employees' intended co-partnership scheme which now stands at £100,000.

# QUESTIONS IN PARLIAMENT

### Royal Assent

MR SPEAKER reported to the House last week that Royal Assent had been given to the Civil Defence (Electricity Undertakings) Act, 1954.

### Fuel Efficiency

AT the request of Mr. G. Nabarro, a short statement was made by Mr L. W. Joynson-Hicks on the industrial fuel efficiency loans scheme. He said that loans could now be considered for non-industrial, as well as industrial concerns, provided a substantial saving in fuel was likely to result, and also provided that the money was not required primarily to replace worn-out equipment. Mr Joynson-Hicks said he would be willing to publish results achieved by the scheme, but warned it would probably be some time before they became apparent. Finally, he said the survey of industrial steam usage with the object of promoting further employment of back pressure turbines was nearly completed.

### Monopolies Report on Cables

AS reported last week, the Minister of Supply has stated that he expected to give the Government's attitude towards the Monopolies Commission's recommendations on the manufacture and supply of electric wires and cables "very soon." When Mr S. T. Swingler expressed some concern at the delay, Mr D. Sandys asked if he appreciated the work involved in following up such reports. The Government had to decide whether they agreed with the recommendations which were often far-reaching, and also study the industry. The Commission took as long as three years to examine the problems.

### Pollution of the Air

THE City of London (Various Powers) Bill, seeking to establish a smokeless zone, gave rise to a three-hour debate on air pollution last week. Inevitably the influence of power stations was remarked upon, particularly by Sir H. Williams. He said there were only three stations in which plant for eliminating sulphur dioxide had been installed, at Fulham, Battersea and Bankside, but he maintained that the plant was not only a failure but aggravated the problem, as it led to the smoke pluming downwards instead of rising high into the air. He also appealed to the British Transport Commission not to bring masses of smoke into the city. On this latter theme, Sir A. Bossom instanced New York, where electric trains took over on the city boundary. Dr Stross said a smokeless zone in the city was inadequate and to get the best results similar zones should also be set up in Westminster, Fulham, Chelsea and Kensington.

Later, Mr S. Hastings suggested that smokeless zones might be harmful, because if putting out the fire was advocated, some people may not have an alternative. The correct thing to do, he said, in cases of fog was to put out the fire and switch on the electric heater. (Mr Hastings' flat is heated entirely by electricity and gas.)

Replying to the debate Mr E. Marples spoke of smokeless fuel appliances. The problems were to provide sufficient fuel to keep pace with the appliances available in smokeless zones; as also to get people to buy and install the appliances.

### Atomic Energy Finance

THE Money Resolution concerning the setting up of the Atomic Energy Authority came before the House last week. Viscount Hinchingbrooke asked that the sums required should be borrowed out of the Consolidated Fund and not be embodied in the Estimates. Past practice was that if a loan was given for something not immediately earning money it should be done above the line on the Budget. The Authority was, however, earning £200,000 p.a. from isotopes and it had been stated that it would earn a substantial amount from the sale of energy to the B.E.A. Mr E. Fletcher, although seeking further information, expressed the hope that it would not be long before atomic energy was generating electricity. This would require much capital expenditure and it was not unreasonable for it to be financed by a loan.

The Minister of Works pointed out that the £50 million p.a. being spent did not include expenditure on weapons. It was the amount used for the civilian side of atomic energy, and was a large sum, but the prize was an enormous one. The Minister confirmed Mr A. Woodburn's assumption that the generation of electricity would eventually be handed over to the B.E.A. and N. of Scotland H.E. Board.

### Trade with Russia ...

FIRM prices and delivery dates could not be quoted by U.K. manufacturers to Soviet buyers because of the uncertainty about the time required before approval to supply was obtained, alleged Sir W. Wakefield last week. He asked what steps were being taken to stop delays in view of expected competition. Mr P. Thorneycroft assured him that they were aware of the difficulties and existing controls were being examined.

### ... and Hungary

TRADE and financial talks with Hungary would open on 25 Mar. in London, Mr P. Thorneycroft told the House last week.

### Exports to America

EVERYTHING possible was being done to stimulate the U.K.'s export trade with America, the President of the Board of Trade told the House last Thursday. It had been pointed out by Mr H. Hughes that the U.S. appeared to be depending more and more on foreign trade. He said that last year the U.S. imported from Britain 75% more than six years ago. The Minister acknowledged this fact and gave credit to the efforts of exporters. His department's services were being extended as far as possible. On the question of differentiation between English and Scottish goods, he did not think it wise to discriminate.

INDUSTRIAL MAINTENANCE

*A special monthly section of the Electrical Times*

# *Cable and Capacitor Economics in Industrial Distribution*

## Part 1

By H. NIMMO, M.Sc., B.E., A.M.I.E.E.

ESSENTIAL factors in the design of an industrial distribution system are the cost of power and the load factor of the works. This article deals with the effect of these two variables on the selection of cable sizes, and goes on to discuss in some detail the economics of power factor correction. In this connection it considers the energy saving involved rather than the savings under a demand tariff, and it is thus applicable not only to industrial concerns taking a public supply, but also to those which generate their own power.

Throughout the article a 420 V, three-phase, 50 c/s supply is taken as the basis of all calculations.

### *Fundamentals of Design*

The design of an industrial distribution system must be based, like any other design, on a quantity of data and a specific object. The data required are of course considerable and varied, but for our present purposes the most important are the cost of power and the load factor which will be attained by the completed installation. The object of the design is to distribute power to a number of given points and at the same time conform to three specific requirements. These three requirements are to ensure that the thermal rating of the conductors should not be exceeded; that power should be delivered with the voltage held within certain clearly defined limits, and that the cost of distribution should be a minimum. For our present purposes the last of these requirements is the most important, since, as will be seen later, its satisfaction, within the range of power costs here considered, necessarily involves satisfaction of the first requirement, and will also involve satisfaction of the second unless circuits are of a length which other considerations of design would render highly improbable.

No consideration will be given here to duplication of feeders to provide stand-by protection, the ring main being the commonest form in which this is found. The provision of such protection is justified as a general principle if the consequences to the process of a failure of a feeder justify the cost of the extra cable involved. It will be seen, however, that in the case of high load factors and/or high power costs it will often be necessary to provide double cables, each of which would, from thermal considerations only, be sufficient to carry the load on the feeder. In such cases, stand-by facilities can be provided by a simple rearrangement of the switchgear, and the cost of distribution reduced to the desired level by operating the ring permanently closed.

The cost of distribution, like all other industrial costs, consists fundamentally of two parts; the direct costs—in this case the cost of the $I^2R$ loss—and the overhead charges on the installation. The copper loss must be calculated on the basis of the whole cost of power to the consumer, and not, if a two part tariff operates, on the basis of the unit charge alone, since the copper loss produces its own portion of the maximum demand and if the power factor is corrected to, or near to, unity, it will produce the correct proportion of demand.

Overhead charges will be dealt with under two heads only; interest on capital, and depreciation. In an industrial undertaking it is fair to assume that depreciation can be dealt with on a sinking fund basis and that the annual payments into the sinking fund can, by being employed in the business of the undertaking, be supposed to produce a net rate of profit of 3½%, and this figure has been used to calculate the rate of depreciation payments. The materials concerned are of a substanital nature and, provided there is no reasonable probability of the whole installation becoming obsolete in a shorter time, it is reasonable to assume that a life of 20 years will be a satisfactory basis on which to calculate depreciation. Interest on capital expenditure is taken at 5% and as there is no recurrent maintenance expense on cable installations, no allowance is made for this.

Table 1. Total cost of Transmitting 500 amps, 1,000 yards

| Cable size | Annual cost in £ at power cost/kWh as below with single shift working | | | | | | Annual cost in £ at power cost/kWh as below with double shift working | | | | | | Annual cost in £ at power cost/kWh as below with triple shift working | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sq. in. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. |
| 2 x ·50 | 1016 | 1110 | 1204 | 1298 | **1391** | **1485** | 1204 | **1391** | **1579** | **1766** | **1954** | **2141** | **1391** | **1673** | **1954** | **2235** | **2516** | **2797** |
| 2 x ·40 | 934 | 1054 | 1174 | **1294** | 1414 | 1534 | **1144** | 1414 | 1654 | 1894 | 2134 | 2374 | 1414 | 1774 | 2134 | 2494 | 2854 | 3214 |
| 2 x ·30 | 844 | **999** | **1155** | 1310 | 1466 | 1621 | 1155 | 1466 | 1777 | 2088 | 2399 | 2710 | 1466 | 1932 | 2399 | 2865 | 3332 | 3798 |
| 2 x ·25 | **837** | 1026 | 1216 | 1405 | 1591 | 1784 | 1216 | 1595 | 1974 | 2352 | 2732 | 3111 | 1595 | 2163 | 2732 | 3300 | 3869 | 4437 |
| 2 x ·20 | 852 | 1090 | 1328 | 1566 | 1804 | 2042 | 1328 | 2004 | 2280 | 2746 | 3232 | 3708 | 1804 | 2518 | 3232 | 3946 | 4660 | 5374 |
| 2 x ·15 | 941 | 1258 | 1575 | 1892 | 2209 | 2526 | 1575 | 2209 | 2843 | 3477 | 4011 | 4745 | 2209 | 3140 | 4111 | 5062 | 6013 | 6964 |

Table 2. Total Cost of Transmitting 400 amps, 1,000 yards

| Cable size | Annual cost in £ at power cost/kWh as below with single shift working | | | | | | Annual cost in £ at power cost/kWh as below with double shift working | | | | | | Annual cost in £ at power cost/kWh as below with triple shift working | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sq in. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. |
| 2 x ·50 | 949 | 1009 | 1069 | 1129 | 1189 | 1249 | 1069 | 1189 | **1309** | **1429** | **1549** | **1669** | 1189 | **1369** | **1549** | **1729** | **1909** | **2089** |
| 2 x ·40 | 848 | 925 | 1002 | 1079 | 1156 | **1233** | 1002 | 1156 | 1310 | 1464 | 1618 | 1772 | 1156 | 1387 | 1618 | 1849 | 2080 | 2311 |
| 2 x ·30 | 737 | 839 | 941 | 1043 | 1145 | 1247 | 941 | 1145 | 1349 | 1557 | 1757 | 1961 | 1145 | 1451 | 1757 | 2063 | 2369 | 2675 |
| ·50 | **654** | **774** | **894** | **1014** | **1134** | 1254 | **894** | **1134** | 1374 | 1614 | 1854 | 2094 | **1134** | 1494 | 1854 | 2214 | 2574 | 2934 |
| ·40 | 655 | 809 | 963 | 1117 | 1271 | 1425 | 963 | 1271 | 1579 | 1887 | 2195 | 2503 | 1271 | 1733 | 2195 | 2657 | 3119 | 3581 |
| 2 x ·15 | 713 | 916 | 1119 | 1322 | 1525 | 1728 | 1119 | 1525 | 1931 | 2337 | 2743 | 3149 | 1525 | 2134 | 2743 | 3352 | 3961 | 4570 |
| 2 x ·10 | 816 | 1113 | 1411 | 1709 | 2006 | 2302 | 1411 | 2006 | 2601 | 3196 | 3791 | 4386 | 2006 | 2899 | 3791 | 4684 | 5576 | 6469 |

Table 3. Total Cost of Transmitting 300 amps, 1,000 yards

| Cable size | Annual cost in £ at power cost/kWh as below with single shift working | | | | | | Annual cost in £ at power cost/kWh as below with double shift working | | | | | | Annual cost in £ at power cost/kWh as below with triple shift working | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sq in. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. |
| 2 x ·50 | 896 | 930 | 964 | 998 | 1013 | 1064 | 964 | 1031 | 1091 | 1166 | 1234 | 1301 | 1031 | 1133 | 1234 | **1325** | **1436** | **1538** |
| 2 x ·40 | 780 | 824 | 867 | 910 | 959 | 1002 | 867 | 953 | 1040 | 1126 | 1212 | **1298** | 953 | 1083 | 1212 | 1342 | 1472 | 1610 |
| 2 x ·30 | 645 | 701 | 757 | 813 | 869 | 925 | 757 | 869 | 981 | 1093 | **1205** | 1317 | 869 | 1037 | **1203** | 1373 | 1541 | 1709 |
| ·50 | 549 | 617 | **684** | **752** | **819** | **887** | **684** | **819** | **974** | **1089** | 1244 | 1379 | **819** | **1032** | 1244 | 1437 | 1649 | 1862 |
| ·40 | 520 | **606** | 693 | 779 | 866 | 952 | 693 | 866 | 1039 | 1212 | 1385 | 1558 | 866 | 1125 | 1385 | 1644 | 1905 | 2163 |
| ·30 | **490** | 683 | 713 | 826 | 938 | 1050 | 714 | 938 | 1162 | 1386 | 1610 | 1834 | 938 | 1274 | 1610 | 1946 | 2284 | 2618 |
| ·20 | 531 | 702 | 874 | 1045 | 1207 | 1388 | 874 | 1217 | 1560 | 1903 | 2246 | 2489 | 1217 | 1731 | 2246 | 2760 | 3275 | 3789 |

Table 4. Total Cost of Transmitting 200 amps, 1,000 yards

| Cable size | Annual cost in £ at power cost/kWh as below with single shift working | | | | | | Annual cost in £ at power cost/kWh as below with double shift working | | | | | | Annual cost in £ at power cost/kWh as below with triple shift working | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sq in. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. |
| 2 x ·40 | 732 | 752 | 771 | 790 | 809 | 828 | 771 | 809 | 849 | 886 | 924 | 963 | 809 | 869 | 926 | 982 | 1040 | 1097 |
| 2 x ·30 | 583 | 608 | 633 | 657 | 682 | 707 | 633 | 682 | 732 | 782 | 832 | 882 | 682 | 757 | 832 | 906 | 981 | 1056 |
| ·50 | 474 | 504 | 534 | 564 | 594 | 624 | 534 | 594 | 654 | **714** | **774** | **834** | 594 | **684** | **774** | **864** | **954** | **1044** |
| ·40 | 424 | 462 | 501 | 539 | 577 | 616 | 501 | 577 | **652** | 731 | 808 | 885 | 577 | 693 | 808 | 923 | 1038 | 1153 |
| ·30 | 367 | **416** | **466** | **506** | **565** | **615** | **466** | **565** | 665 | 746 | 864 | 964 | **565** | 715 | 864 | 1013 | 1163 | 1311 |
| ·20 | **345** | 424 | 603 | 581 | 660 | 739 | 503 | 660 | 818 | 975 | 1132 | 1290 | 660 | 896 | 1132 | 1368 | 1604 | 1841 |
| ·10 | 409 | 558 | 707 | 856 | 1005 | 1154 | 707 | 1005 | 1303 | 1601 | 1899 | 2197 | 1005 | 1452 | 1899 | 2346 | 2793 | 3240 |

Table 5. Total Cost of Transmitting 150 amps, 1,000 yards

| Cable size | Annual cost in £ at power cost/kWh as below with single shift working | | | | | | Annual cost in £ at power cost/kWh as below with double shift working | | | | | | Annual cost in £ at power cost/kWh as below with triple shift working | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sq in. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. |
| 2 x ·30 | 561 | 575 | 589 | 602 | 617 | 631 | 589 | 617 | 645 | 673 | 721 | 729 | 617 | 659 | 711 | 743 | 785 | 827 |
| ·50 | 448 | 465 | 482 | 500 | 516 | 533 | 482 | 516 | 550 | 583 | 617 | 651 | 516 | 567 | 617 | 668 | **719** | **769** |
| ·40 | 390 | 412 | 433 | 445 | 477 | 498 | 433 | 477 | 520 | 563 | 636 | **649** | 477 | 541 | 606 | **671** | 736 | 801 |
| ·30 | 322 | 350 | 378 | 406 | **434** | **462** | 378 | **434** | **490** | **546** | **604** | 658 | **434** | **518** | **602** | 686 | 770 | 854 |
| ·20 | **274** | **316** | **359** | **402** | 445 | 488 | **359** | 445 | 531 | 616 | 802 | 788 | 445 | 574 | 702 | 730 | 959 | 1088 |
| ·10 | 278 | 362 | 446 | 529 | 613 | 697 | 446 | 613 | 780 | 848 | 1115 | 1282 | 613 | 864 | 1115 | 1366 | 1617 | 1868 |
| ·06 | 362 | 502 | 643 | 783 | 924 | 1064 | 643 | 924 | 1205 | 1486 | 1767 | 2048 | 924 | 1345 | 1767 | 2188 | 2610 | 3031 |

Table 6. Total Cost of Transmitting 100 amps, 1,000 yards

| Cable size | Annual cost in £ at power cost/kWh as below with single shift working | | | | | | Annual cost in £ at power cost/kWh as below with double shift working | | | | | | Annual cost in £ at power cost/kWh as below with triple shift working | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sq in. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. |
| ·50 | 429 | 437 | 444 | 452 | 459 | 467 | 444 | 459 | 474 | 489 | 504 | 519 | 459 | 482 | 504 | 527 | 549 | 572 |
| ·40 | 366 | 376 | 385 | 395 | 405 | 414 | 385 | 405 | 424 | 443 | 462 | 482 | 405 | 433 | 462 | 492 | 520 | 547 |
| ·30 | 292 | 304 | 317 | 329 | 342 | 355 | 317 | 342 | 367 | 392 | **418** | **443** | 342 | 380 | **418** | **456** | **493** | **531** |
| ·20 | 226 | 246 | 266 | **284** | **304** | **324** | 266 | **304** | **344** | **382** | 420 | 460 | **304** | **362** | 421 | 479 | 547 | 595 |
| ·10 | **185** | **222** | **259** | 297 | 334 | 371 | **259** | 334 | 408 | 483 | 557 | 631 | 334 | 445 | 557 | 669 | 780 | 892 |
| ·06 | 206 | 267 | 331 | 393 | 455 | 518 | 331 | 455 | 580 | 705 | 830 | 955 | 454 | 643 | 830 | 1017 | 1204 | 1391 |
| ·04 | 255 | 350 | 445 | 539 | 634 | 729 | 445 | 634 | 823 | 1012 | 1202 | 1391 | 634 | 918 | 1212 | 1486 | 1770 | 2054 |

Table 7. Total Cost of Transmitting 50 amps, 1,000 yards

| Cable size | Annual cost in £ at power cost/kWh as below with single shift working | | | | | | Annual cost in £ at power cost/kWh as below with double shift working | | | | | | Annual cost in £ at power cost/kWh as below with triple shift working | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sq in. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. |
| ·30 | 273 | 276 | 279 | 282 | 285 | 288 | 279 | 285 | 291 | 298 | 304 | 310 | 285 | 294 | 304 | 313 | 322 | 332 |
| ·20 | 197 | 202 | 207 | 212 | 217 | 221 | 207 | 217 | 226 | 235 | 245 | 255 | 217 | 231 | 245 | 260 | **274** | **288** |
| ·10 | 129 | 141 | 148 | **157** | **166** | **176** | 148 | **166** | **185** | **204** | **223** | **241** | **166** | **194** | **222** | **250** | 278 | 306 |
| ·06 | **112** | **128** | **144** | 159 | 175 | 190 | **144** | 175 | 206 | 237 | 268 | 300 | 175 | 222 | 268 | 315 | 362 | 409 |
| ·04 | 113 | 137 | 161 | 185 | 208 | 272 | 161 | 208 | 256 | 303 | 350 | 398 | 208 | 279 | 351 | 422 | 495 | 564 |
| ·0225 | 134 | 177 | 218 | 262 | 305 | 356 | 218 | 305 | 388 | 474 | 561 | 654 | 305 | 433 | 561 | 689 | 817 | 945 |
| ·01 | 220 | 309 | 399 | 488 | 578 | 667 | 399 | 578 | 757 | 936 | 1115 | 1294 | 578 | 846 | 1115 | 1383 | 1652 | 1920 |

Cable prices are calculated on prices of copper and lead current at the end of January, 1954, i.e. Copper £225 per ton and lead £85 per ton and are all based on 660V grade, 3-core p.i.l.c.s.w.a. cables with armouring left bright, as will be suitable for indoor installation, and a further 15% is added to the price for installation costs. A further assumption that is made is that the largest cable that is suitable for installation is a 0·50 sq in. and that it will not be practicable to use more than two such cables in parallel. The last proviso arises from the fact that standard designs of switchgear do not normally provide for more than two large multicore cables, except in the very large sizes, and the gain in providing greater sections of copper for feeders would be lost in providing for additional capital charges.

### *Selection of Cables*

A method of determining the economic size of cables that is frequently used, is to obtain a suitable figure for copper cost and determine a section which will produce a copper loss equal to the capital charges on this size of conductor. This method is reasonably valid in calculating overhead lines, where the cost of the conductor is fairly nearly proportional to the conductor area, but in connection with cables this method may produce results which are wildly wrong, especially in connection with the smaller cable sizes in which the cost of cable per sq in. of copper increases almost as fast with reducing section as the cost of the copper loss. This is clearly illustrated in Fig. 1 where the cost of cables per sq in. of copper is plotted against the section of the conductor. To satisfy the classical method this curve should be a straight line parallel to the axis "Conductor Area" but it is plainly far from that. In consequence the only remaining method of choosing economic cable sizes is the empiric one and Tables 1 to 9 have been calculated to give the total costs of a cable installation at various currents, various load factors and various costs of power, and from these tables a selection of the most economic size of cable may be made.

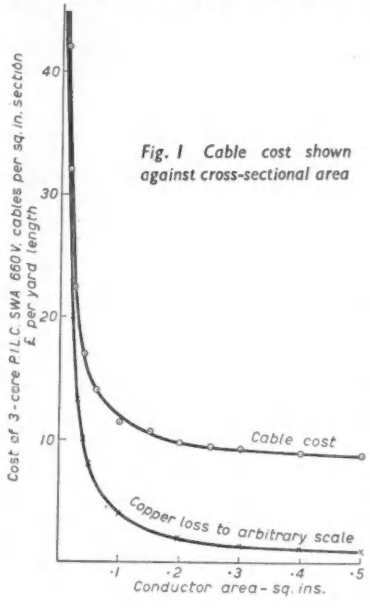



*Fig. 1 Cable cost shown against cross-sectional area*

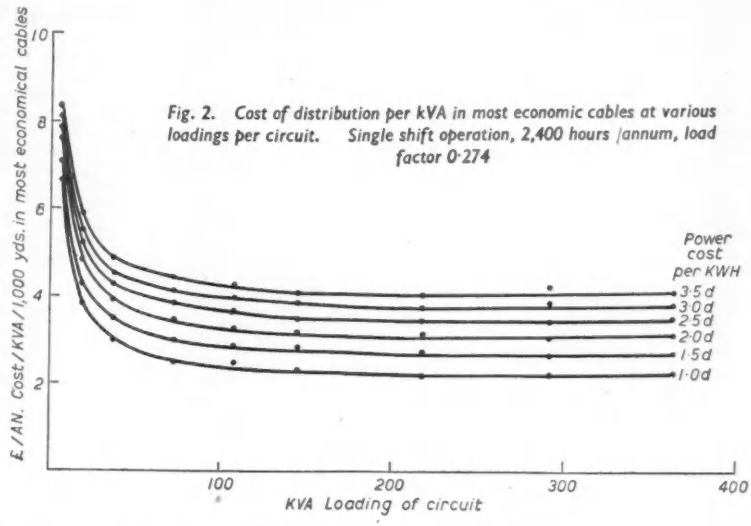



*Fig. 2. Cost of distribution per kVA in most economic cables at various loadings per circuit. Single shift operation, 2,400 hours /annum, load factor 0·274*

Certain matters in connection with these tables require discussion. Load factors correspond to three different conditions of production. First, working eight hours a day for six days a week on 50 weeks of the year, amounting to 2,400 hours a year; secondly working two eight-hour shifts on the same number of days amounting to 4,800 hours a year; thirdly working three shifts a day amounting to 7,200 hours a year. Costs of power on which cost of copper loss has been calculated, ranging from 1d. to 3½d. per kWh include any separate demand charge, if such exists and are therefore calculated from the gross charge made by the supplier divided by the number of kWh consumed. Where power is generated by the works it should be the calculated cost of power per unit at the l.v. busbars. The range given in these tables is fairly high, but there are conditions existing at the present moment which will make a power cost of 3½d. within the range of contemplation.

In Tables 1 to 9 it will be appreciated that the costs given are all for 3-core cables running with a three-phase balanced load. It will also be noted that under each current range the smallest cable or combination of cables mentioned in the tables is the minimum sec-

Table 8. Total Cost of Transmitting 25 amps, 1,000 yards

| Cable size | Annual cost in £ at power cost/kWh as below with single shift working | | | | | | Annual cost in £ at power cost/kWh as below with double shift working | | | | | | Annual cost in £ at power cost/kWh as below with triple shift working | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sq in. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. |
| ·10 | 115 | 117 | 120 | 122 | 125 | 127 | 120 | 125 | 129 | 134 | 139 | 143 | 125 | 132 | 139 | 145 | 152 | **160** |
| ·06 | 88 | 92 | 97 | 101 | 105 | 108 | 97 | 105 | **112** | **120** | **128** | **136** | 105 | **116** | **128** | **140** | **151** | 163 |
| ·04 | 78 | 83 | **90** | **95** | **101** | **107** | **90** | **101** | 113 | 124 | 135 | 148 | **101** | 118 | 135 | 152 | 170 | 187 |
| ·0225 | **70** | **77** | 92 | 102 | 113 | 123 | 92 | 113 | 134 | 155 | 176 | 197 | 113 | 144 | 176 | 208 | 240 | 271 |
| ·01 | 86 | 108 | 130 | 153 | 175 | 198 | 130 | 175 | 220 | 265 | 309 | 354 | 175 | 242 | 309 | 377 | 443 | 511 |

Table 9. Total Cost of Transmitting 10 amps, 1,000 yards

| Cable size | Annual cost in £ at power cost/kWh as below with single shift working | | | | | | Annual cost in £ at power cost/kWh as below with double shift working | | | | | | Annual cost in £ at power cost/kWh as below with triple shift working | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| sq in. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. |
| ·04 | 68 | 68·9 | 69·9 | 70·8 | 71·8 | 72·7 | 69·9 | 71·8 | 73·7 | 75·5 | 77·5 | 79·3 | 71·8 | 74·6 | 77·5 | 80·3 | 83·1 | 85·9 |
| ·0225 | 52·6 | 54·3 | 56 | **57·7** | **59·3** | **61** | 56 | **59·3** | **62·7** | **66·2** | **69·5** | **74·0** | 59·3 | **64·4** | **69·5** | **75·6** | **80·1** | **84·7** |
| ·0145 | 51·2 | 53·8 | 56·4 | 58·9 | 61·5 | 64·1 | 56·4 | 61·5 | 66·6 | 71·7 | 76·9 | 82 | **61·5** | 69·3 | 76·9 | 84·6 | 92·3 | 100 |
| ·01 | **48·2** | **51·7** | **55·3** | 58·9 | 62·5 | 66·2 | **55·3** | 62·5 | 69·7 | 76·8 | 84·0 | 91 | 62·5 | 73·5 | 83·0 | 94·7 | 105 | 116 |

Table 10. Costs of Distribution in £/kVA/1,000 yards in most economical cables at various kVA loadings per circuit

| kVA at 420 V | Power cost per kWh single shift working 2,400 hours | | | | | | Power cost per kWh double shift working 4,800 hours per annum | | | | | | Power cost per kWh treble shift working 7,200 hours per annum | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. | 1d. | 1½d. | 2d. | 2½d. | 3d. | 3½d. |
| 364 | 2·30 | 2·74 | 3·18 | 3·55 | 3·82 | **4·08** | 3·15 | 3·82 | **4·34** | **4·86** | **5·37** | **5·88** | **3·82** | **4·60** | **5·37** | **61·4** | **6·91** | **7·69** |
| 291 | 2·25 | 2·66 | 3·07 | 3·48 | 3·90 | 4·24 | 3·07 | 3·90 | 4·50 | 4·91 | **5·32** | **5·74** | 3·90 | 4·70 | **5·33** | **5·94** | **6·56** | **7·18** |
| 218 | 2·25 | 2·78 | 3·14 | 3·45 | 3·76 | 4·07 | 3·14 | 3·76 | 4·47 | 5·00 | 5·52 | 5·95 | 3·76 | 4·73 | 5·53 | 6·08 | 6·59 | **7·05** |
| 145·5 | 2·37 | 2·86 | 3·20 | 3·48 | 3·88 | 4·22 | 3·20 | 3·88 | 4·48 | 4·91 | 5·32 | 5·74 | 3·88 | 4·70 | 5·32 | 5·94 | 6·56 | 7·18 |
| 109 | 2·51 | 2·90 | 3·29 | 3·69 | 3·98 | 4·24 | 3·29 | 3·98 | 4·50 | 5·01 | 5·58 | 5·95 | 3·98 | 4·75 | 5·52 | 6·15 | 6·60 | 7·05 |
| 72·8 | 2·54 | 3·05 | 3·55 | 3·90 | 4·17 | 4·45 | 3·56 | 4·18 | 4·73 | 5·24 | 5·74 | 6·08 | 4·18 | 4·95 | 5·74 | 6·26 | 6·77 | 7·29 |
| 36·4 | 3·08 | 3·52 | 3·95 | 4·31 | 4·56 | 4·84 | 3·95 | 4·56 | 5·08 | 5·61 | 6·13 | 6·52 | 4·56 | 5·33 | 6·10 | 6·87 | 7·53 | 7·91 |
| 18·2 | 3·85 | 4·23 | 4·94 | 5·22 | 5·55 | 5·88 | 4·94 | 5·55 | 6·15 | 6·59 | 7·03 | 7·47 | 5·55 | 6·37 | 7·03 | 7·69 | 8·30 | 8·79 |
| 7·27 | 6·63 | 7·11 | 7·61 | 7·94 | 8·16 | 8·39 | 7·61 | 8·16 | 8·63 | 9·11 | 9·56 | 10·2 | 8·46 | 8·86 | 9·60 | 10·4 | 11·0 | 11·7 |

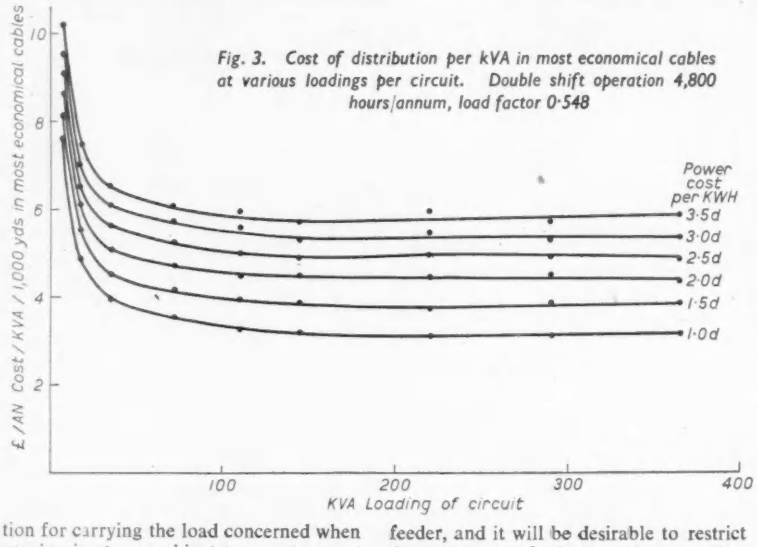



*Fig. 3. Cost of distribution per kVA in most economical cables at various loadings per circuit. Double shift operation 4,800 hours/annum, load factor 0·548*

tion for carrying the load concerned when run in air at an ambient temperature not exceeding 25° C. The most economical cable for each condition is indicated in bold type in the tables, and it will be immediately apparent that heating conditions, even if volt-drop requirements are satisfied, are not a reliable guide to the size of cable which should be installed. Only in the case of the very small cables in Table 9, and then only with low load factors, is the smallest cable in the table the most economical and even this case is deceptive since the current concerned, 10 amps, is only one-fifth of the maximum thermal rating of this cable.

In connection with the tables dealing with the heavier current ranges, 500, 400 and 300 amps, it will be noted that, at the higher load factors and higher power costs, the minimum cost is not attainable even with the largest cable practicable. This does not, however, necessarily imply that under the corresponding conditions the current should be restricted to avoid cable sizes where the minimum cost can not be obtained. If smaller currents per feeder are designed for, there will be an extra cost on the whole installation for switches and therefore the costs on the lower current proposal should, for the sake of comparison, be loaded with a suitable proportion of the extra capital charges arising from the larger number of switches required to distribute the whole load. For instance, if it is decided that it may not be economical, in existing conditions, to use 500 amps per feeder, and it will be desirable to restrict the current per feeder to 400 amps, then the cost of distribution on each 400 amp feeder must, for the sake of comparison, have added to it one-fifth of the capital charges for an extra switch, and then, especially if the feeders are rather short, it may easily be found that this extra charge will make the 500 amp cost of distribution smaller than the 400 amp.

### *Cost of Distribution per kVA*

So far we have considered costs of distribution on an absolute basis only and consequently have very little information on the overall principles of design which should form a guide to the design of a system which will conform to the primary object of having the least overall cost. It is necessary therefore to consider how overall costs can be kept as low as possible, and to do this it is necessary to consider how costs per kVA distributed vary with varying values of circuit kVA. From Tables 1 to 9 the costs, under the varying conditions considered, of the most economical cable for its kVA have been divided by the kVA carried and the results of this process are given in Table 10 on a basis of the cost per annum of distributing one kVA to a distance of 1,000 yards at the stated circuit load and under the different conditions of load factor and power cost which were covered by the previous tables. Costs which arise from circumstances where the minimum cost for that specific kVA was not attainable are indicated by bold type.

A series of curves to illustrate this table is shown for the three conditions of load factors in Figs. 2, 3 and 4. It should be noted, however, that these curves do not represent continuous functions since, whenever a change occurs

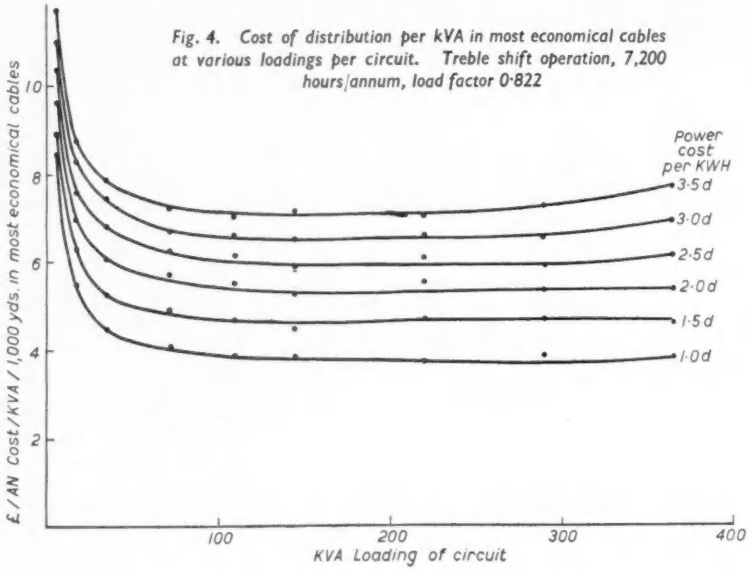



*Fig. 4. Cost of distribution per kVA in most economical cables at various loadings per circuit. Treble shift operation, 7,200 hours/annum, load factor 0·822*

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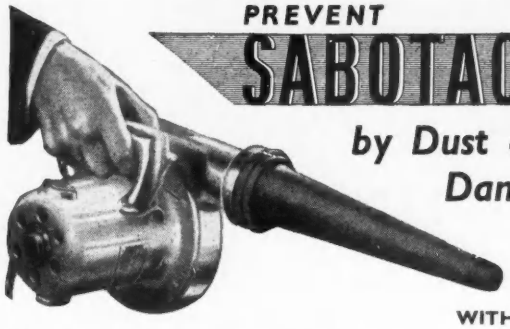

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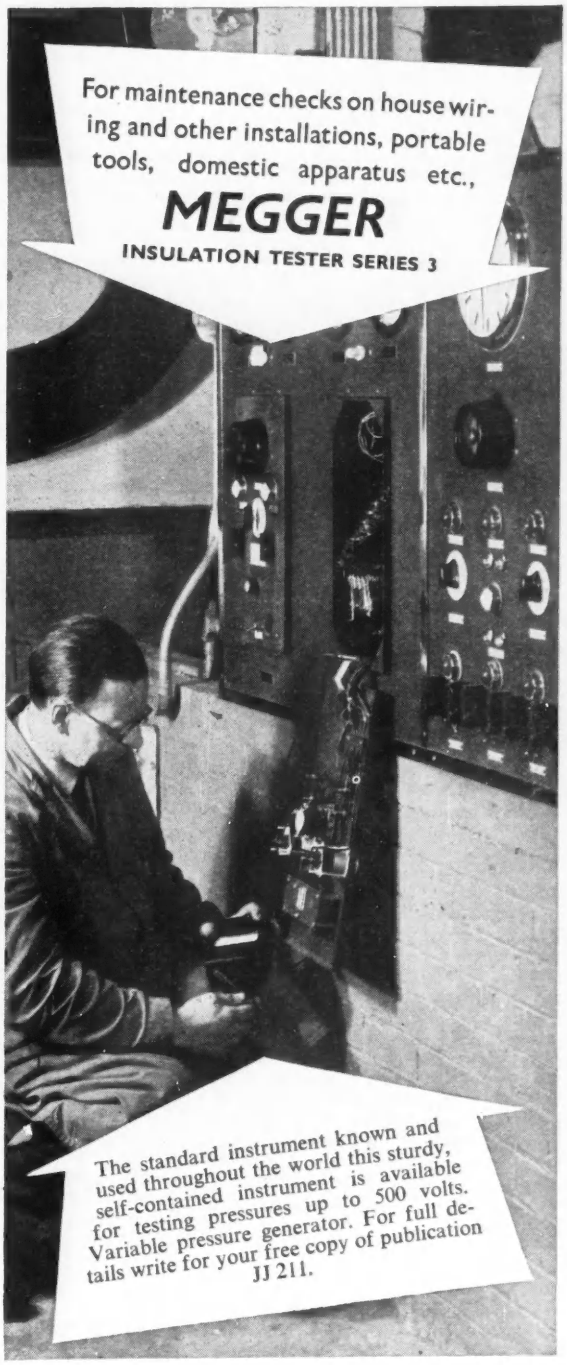
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from one cable size to another, there will be a discontinuity in the curve, but they do serve to illustrate in a clear manner the general way in which the cost per kVA changes with alteration in the load on the circuit.

These curves and Table 10 from which they are derived clearly show that there is a considerable increase in the cost of distribution per kVA as the kVA per circuit decreases. A second distinct increase also appears at the heavy current end, especially of the high load factor results where the minimum cost cable size was not attainable. An immediate application of these curves to design is that it will pay to make final subcircuits, in which the cost per kVA will be the highest, as short as possible, and this will normally involve restricting the number of ways in the final distribution boards to rather low values unless the load utilisation points are highly concentrated.

### *Power Factor*

Values so far obtained refer to costs per kVA distributed, but the primary purpose of the system is to distribute kW rather than kVA. If the power factor is unity, the costs per kVA are equal to the costs per kW, but at any other power factor the costs per kV exceed the costs per kVA. There is therefore an obvious advantage in improving the power factor through the cables so that the cost per kW is kept as near as possible to the cost per kVA.

The application of static condensers for power factor correction is very well known but in general these have been installed in order to reduce the maximum demand of the system and so obtain more favourable terms from the power supplier, and so they are normally connected near the point of origin of the l.v. system, and under these conditions do not affect the power factor of the current carried by the distribution system. There is an obvious case therefore for enquiring whether greater gains might not be achieved by connecting them deeper into the system, and in fact whether it would not be most economical to connect them as near to the point of utilisation as is possible.

The economics aspects of deciding the positioning of power factor correction capacitors in the distribution system is to be the subject of Part 2 of this article, in a future number of "Industrial Maintenance."

*(To be concluded)*

# *GOOD DESIGN SPEEDS REPAIRS*

**by W. H. A.**

NOTHING irritates a maintenance engineer so much as unnecessary delays in getting a piece of plant back into operation. The maintenance man's one thought is to get the machine in motion at the earliest possible moment. If he fails in this he is in trouble.

What does he find? Guards with from sixty to one hundred screws to be taken out before access can be gained to the faulty part, and, incidentally all to be replaced before handing the machine back to the operator.

The answer to this is so simple and well known that it is one of the great puzzles to know why this sin is committed on probably 60% of new machines. Stiffening the edges of the cover sheets and fixing by means of a few hook plates, pins or even wing-nuts can be a great time-saver.

On some single-phase machines the centrifugal switches are of very poor design, the parts being suited more to a radio than to the arduous service of a power drive. There is very little excuse for this except that of expense, and in this case, the benefits of a reasonable switching arrangement far outweigh the value of the saving which could be made by cheap arrangements. In this connection, too, the motor designers might note that there is no necessity to place this switch inside the end covers of the motor. How the electricians would welcome a switch which would be exposed on removing a small cover and which could be replaced in a matter of five minutes or so without going inside.

It is high time, also, that the designers stopped making every piece of apparatus look like a streamlined unit of the jet age. Wouldn't it be sensible to make an electric motor look like an electric motor, and a switch resemble a switch? The writer recalls one large machine, the designer of which took such pride in the sleek smooth lines of the sheet metal casing that he placed the bearings inside.

Every few months the bearing covers were to be removed and grease packed into the ball-races. It didn't work out that way and a few seizures resulted. Now grease nipples are fitted outside and tubes connected to the bearings.

On another occasion a new model of a well-known machine arrived in a factory for testing. The maintenance team took the liveliest interest as the unit looked like an atomic gun-carriage. It was connected up to the supply but didn't respond. With great difficulty the sheet steel covers were removed, and the original machine was exposed. The "improved" design consisted of covering the unit with pretentious sheet steel nonsense.

Inaccessibility is another great bugbear. A chain-drive was encased in a very well made guard which acted also as an oil bath. It was decided to drop the cover to inspect the chain. To the Chief Engineer's horror it took a competent fitter one and a quarter hours to get the guard off. This was because of its most inaccessible position.

Now this might well have been a breakdown and the seventy-five minutes would have been added to the repair bill. It is the designer's duty not only to create a unit which will work, but also to ensure that maintenance will be kept to a minimum.

It is not unknown for "stylised" machines to have no ready means of being lifted for transport. The provision of an eyebolt or eyebolts at the centre of gravity is an obvious asset, and should be included as a "must."

In certain food factories where there is trouble with insects which live on the raw material the standard type of motor slide rails is a perfect breeding ground. It is difficult, if not impossible, to keep such rails free from ingredient dust, and hours of labour can be spent on cleaning to keep down infestation. Slotted channels with the toes of the metal outwards are much cleaner from this viewpoint.

How often does one see the spare motors in a factory store lying anyhow, without regard to horsepower or speed. In an emergency time is wasted bending over name-plates in an effort to identify suitable machines. A motor rack suitably marked off will prove to be an excellent storage for the smaller machines, probably five h.p. downwards. The larger motors can perhaps be left on the floor.

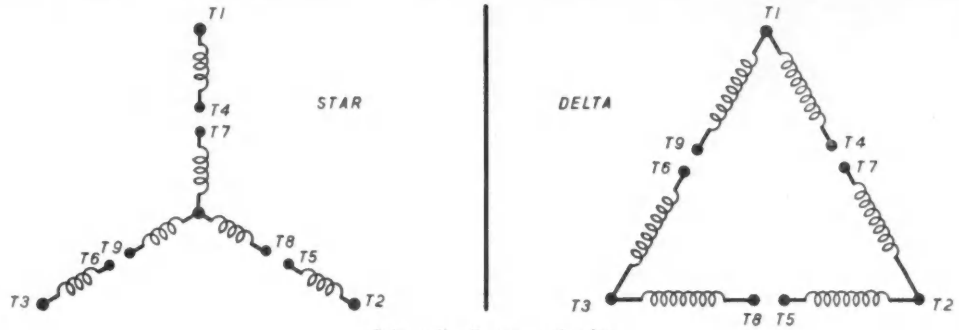
Starters, too, obviously should be stored in a sensible fashion as it is not unknown for the Engineering Office to insist that a missing piece of apparatus was included in the stock sheets at the last stocktaking and has not since been booked out. This, of course, refers to the smaller electrical department which does not have a storeman.

One idea which is rarely exploited is to write a table of eventualities. If such an accident should happen the correct procedure is to fit . . . . . How often is a junior left undecided on a proper course of action. Sometimes quite a staff is standing awaiting decisions while a Chief puzzles over the best way to get out of trouble. A little forethought when waters are running smooth can help considerably in times of stress.

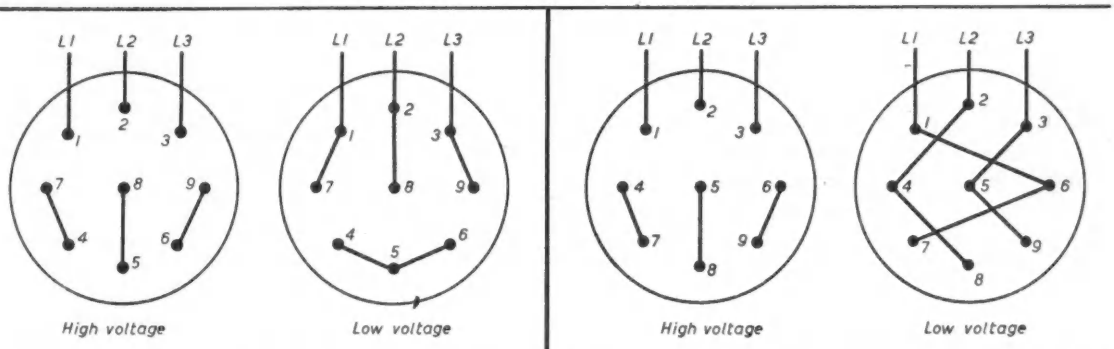
As processes become more co-ordinated, and long lines of machinery are connected together to keep the product moving continuously it is essential to cut stoppages of even the simplest unit to the absolute minimum. The successful plant engineer is the one who is not above giving the most serious thought to every means of keeping the wheels in motion.

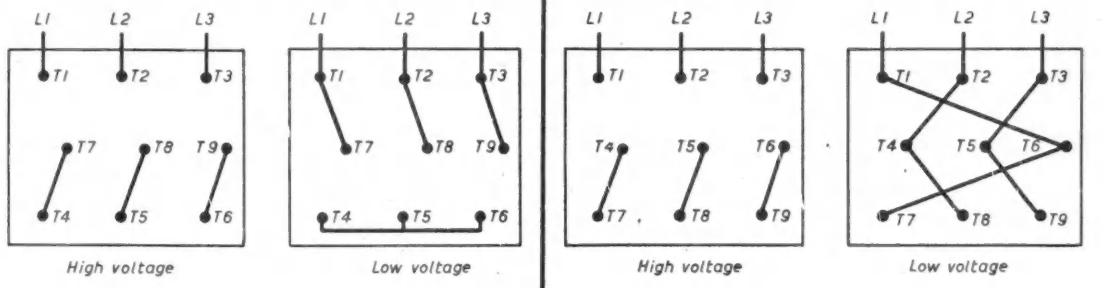
# *Dual Voltage Connections for American Motors*

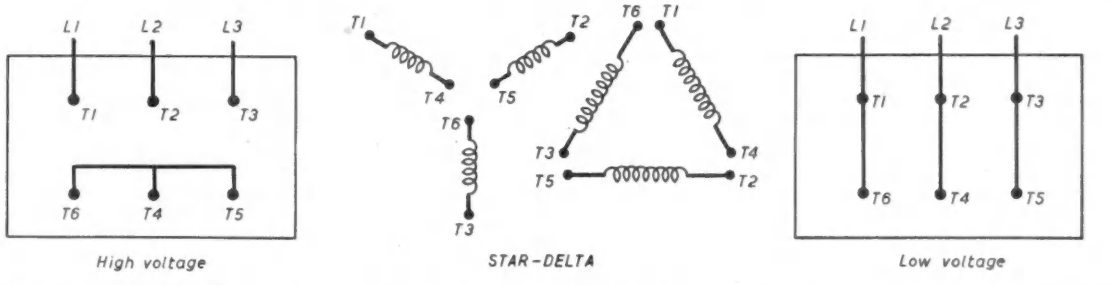
**DATA SHEET 3**




*Schematic diagrams showing terminal markings of circuits*




The terminal arrangements used in three-phase dual-voltage American motors vary. Some have a conventional junction box with terminals arranged in either circular or rectangular formation, as shown above, while others are provided with 9 long leads each carrying an identification tag or numbered lug.

# *INCENTIVE PAYMENTS*

## *in Plant Maintenance Departments*

by **H. E. KEARSEY,** A.M.I.Mech.E.

WHILE the need for incentive payment in industry has now become generally recognised, the practicability of its successful application in the field of plant maintenance is largely disputed, or accepted only with reluctance. In spite of this, however, more and more firms are installing schemes in their works engineering departments.

What are the reasons? First the production workers are making appreciable additions to their base pay in the form of bonus earnings and the remuneration of skilled maintenance workers must be kept in step to avoid dissatisfaction. At the same time, national policy demands that pay increases should not be given unless accompanied by corresponding improvement in productivity. Each individual worker must be encouraged to play his part and there must be some reward for success.

Secondly, most managements are now endeavouring to improve their methods of organising and planning work. The techniques of work study are widely recommended for this purpose but, to secure the acceptance of the men in the shops to the close investigation of their activities which is necessarily involved, there must be some concrete promise of compensation in the form of higher earnings. How can this be given, except through the use of incentive payment schemes?

Thirdly, the pioneer schemes installed by a small number of firms during the past seven years have provided a background of knowledge and experience to show that successful application is possible. The publicity given to their efforts is encouraging other firms to follow suit.

It must also be recognised that many of the difficulties met when applying incentive payment to maintenance work are encountered equally when dealing with schemes for production workers engaged in the more complicated and varied processes. Only a few of the problems are really peculiar to plant maintenance. The fundamental principles which should govern incentive payment schemes are common to all industries, trades, and types of work.

Used as a term, "plant maintenance" can be taken as those activities normally covered by the works engineering department, whether mechanical, electrical constructional, or building. The term can be misleading, for much of the work can frequently be extensions and additions to plant and building rather than their maintenance in a fit state for productive use. To get the problem of incentive application into proper perspective, it is desirable to classify the various types of jobs which come within the scope of this interpretation of Plant Maintenance. They can be conveniently analysed under six categories, namely: (1) Capital Extensions; (2) Additions and Alterations; (3) Routine Maintenance; (4) Breakdowns; (5) Repairs; (6) Overhauls.

Capital extensions include all those jobs, usually of a comparatively major character, such as new plant and buildings, which clearly increase the assets of the business. Full information and details will be available before work on the project commences and advance planning of the work thus becomes possible.

Additions and alterations refer to the jobs, often of a minor character, which arise from the need to modify layouts, to alter buildings and services, to move the position of machinery and other managerial requirements. The jobs are capable of specification and can be planned in advance of execution.

Routine maintenance includes all work involved in keeping plant, services, and buildings in good running order such as inspection, lubrication, cleaning, protection, and minor servicing but excluding major jobs such as overhauls. Such work can be scheduled.

Breakdowns refer to the emergency work of putting plant into service following a cessation of production for some cause or other. The work must be done with maximum of speed and cannot be foreseen. Also in this category are all minor jobs of an emergency character.

Repairs include jobs of a comparatively major size which have arisen as a result of actual or anticipated breakdown.

Overhauls refer to the planned withdrawal of plant from production for the purpose of thorough reconditioning.

The characteristic points of each category of job must be borne in mind when considering not only the forms of incentive which are likely to be most suitable but also, and even more important, the procedure for assessing standards of performance for the wide variety of jobs.

### *General Requirements*

The scheme must be remunerative to the employer, leading to reduction in costs and greater efficiency. All extra expenditure incurred in installing and running the scheme must be taken into account. It must never be used merely as a means for paying higher wages, or of attracting labour from other factories, without any increase in productivity.

The scale of bonus payment in return for this greater productivity should be sufficiently generous to encourage labour to give sustained and unrestricted application to its tasks.

Work study in one of its forms should be used to assess the output targets and time standards on which bonus payment is based. "Guestimating" should be kept to a minimum. Quality must be safeguarded. As far as practicable, the scheme must avoid giving encouragement to "scamping" of work.

Not only should basic rates of pay be guaranteed but there should be some indication given as to the level of bonus earnings which the average worker can expect to receive in return for a sustained application to his job. It is most important that employees both understand and accept the principles and practice of the scheme, particularly the details of bonus calculation. A scheme should not be introduced without full consultation with the recognised representatives and without publicising relevant information. A man must be able to compute his bonus earning from facts in his possession.

Individual incentives are the most successful from the point of productivity. But the character of the jobs may demand the use of group incentives. Then the size of the team or group should be kept as low as possible, eight in number at the most. Wherever practicable, there must be written codification and specification of the tasks for which bonus is to be paid. These provide protection for both employer and employee, help to avoid disputes, and in their preparation lead to substantial savings.

All personnel should have an opportunity of increasing their earnings but "unearned" or "lieu" bonuses should never be paid. Bonus should be a reward for increased productivity or for particularly meritorious service of some kind.

The prompt calculation and payment of bonus earnings is very necessary. Payment should never be less frequent than weekly.

### *Types of Incentive Schemes*

Broadly, there are five possibilities for use in plant maintenance, namely: (1) Individual incentive; (2) Group incentive; (3) "Downtime" bonus; (4) Task bonus; (5) Merit bonus.

The different brands of incentive schemes are too often described in terms of rather complicated formulae showing the connection between such factors as time allowed, time taken, time saved, percentage bonus, total earnings, and cost. It is preferable to consider the different schemes on a simpler basis. This can be done by making a straight comparison between bonus earnings and amount of output. This comparison can be shown graphically by plotting the relationship.

The effective rate at which a man works, i.e. produces output, is generally known as his performance in the terminology of incentives; the relationship can thus be known as the performance-bonus earnings scale. Each brand of scheme has its own performance-bonus earnings scale.

Individual incentives, as a category, include schemes where each man is paid according to his personal performance and where his earnings are not specifically limited. A form of performance-bonus earnings scale well suited to plant maintenance is that known as "low geared". In a "low geared" scheme, bonus starts to become payable at a comparatively low level of performance but the amount of bonus earned does not increase proportionately with the increase in performance, i.e. if performance improves by thirty per cent over and above the basic performance at which bonus becomes payable, the percentage bonus paid will be some figure less than thirty per cent. Amongst such schemes are the Halsey, Weir and Rowan.

Another form of performance-bonus earnings scale, in several ways superior to the "low geared," is established by means of a "pro rata" relationship, independent of actual wage rates, between performance and bonus earnings. As with the "low geared" scale, bonus starts to become payable at a rather low level.

### *Basic Principle*

The axiomatic principle governing all performance-bonus earnings scales must be that the man of average skill, suited to his job and working conscientiously throughout the day, must be in a position to earn the amount stipulated under employer-trade union agreements.

Group incentives refer to schemes where individual earnings depend upon the collective results of the efforts of several men. The same forms of performance-bonus earnings scales as used for individual incentives are suitable for application.

"Down time" schemes link bonus earnings with the amount of plant down time. The percentage of down time to availability time is related on some arbitrary scale to bonus earnings. As percentage down time increases, so bonus earnings fall and vice-versa. The scheme has apparent advantages, particularly when certain tradesmen are specialising on groups of plant, lifts or motors for example, or when maintenance men are allocated permanently to specific departments. There are, however, disadvantages in practice. Expenditure on replacement parts may increase unnecessarily, factors outside the control of the maintenance men may cause appreciable loss of bonus with resulting dissatisfaction, and managerial improvements may allow the earning of bonus with even less effort on the men's part. Once installed, such schemes are difficult to modify or withdraw.

Task bonus refers to schemes in which a fixed amount of bonus is paid in return for the carrying out of specified duties within a stated allowed time. While the amount of bonus is limited, it does provide a means of rewarding men who are completing their tasks satisfactorily within a time schedule. For this reason, the method can be specially valuable when applied to routine maintenance on a planned basis.

Merit rating aims at varying a man's bonus earnings in accordance with his actual worth through periodic assessment of his merit. The determination of merit is made, usually monthly, by an appraisal of those factors selected as being most significant in the particular craft or job. The assessment is made in terms of points, a maximum being set for each of the factors, the sum of the points for the factors then representing the total score on which bonus earnings are computed for payment during the interval, usually four weeks, until the time of the next assessment. The scheme endeavours to cater for those jobs where the value of the employee cannot be judged in terms of his physical output or where the amount of physical output may be of small importance compared with other factors. Merit rating has one great theoretical advantage. It can reflect the true worth of an employee more accurately in terms of bonus earnings than can any other incentive scheme provided that the assessment be carried out objectively and fairly. In practice, there is one very serious disadvantage. The employee who is "down pointed," with a resultant fall in bonus earnings, will be emotionally disturbed, and probably become disgruntled. The deliberations and decisions of an assessment committee, in the view of an employee, will be no substitute for factual assessment in terms of actual quantitative output.

RECOMMENDED SCHEMES OF BONUS PAYMENTS

| | |
|---|---|
| Capital extensions | Individual incentive |
| Additions and Alterations | Individual incentive |
| Routine Maintenance | Task bonus |
| Breakdowns | Merit bonus |
| Repairs | Individual incentive |
| Overhauls | Individual incentive |
| Specialist work (such as testing for faults and experimental running of plant) | Merit bonus |
| Indirect work (such as shop cleaning) | Merit bonus and/or task bonus |

### *Practical Application*

The application of incentives to plant maintenance can be considered in three parts:

(1) The techniques to be followed in establishing work values or standards of performance: formerly known as ratefixing, now termed work measurement or analytical estimating.

(2) The formulae to be used in relating achievement, in terms of performance standards, to bonus earnings.

(3) The procedure to be followed in the running of the scheme, i.e responsibilities, clerical routine, type of forms, and so forth.

Work values, or allowed times, are based on the times which should be taken to perform specified tasks by men of average skill, suited to the particular task, and working conscientiously throughout the day. Time for relaxation and personal needs must be included in the values and the assumed working pace must not be such as to make a man unduly tired at the end of a normal day's work.

To carry out the assessment of work values, trained estimators are required. The success of the scheme depends almost entirely upon the selection and training of these men. Estimators should be drawn from the ranks of skilled tradesmen and, if possible, be trained in the techniques of method study and work measurement. In addition, they must have high integrity of character.

The steps in work assessment are as follows:

(1) The project or job as a whole must be clearly understood by the estimator. In the absence of drawings, work schedules, or specifications, he must be thoroughly briefed by his chief, by a staff engineer or by the craft foreman. He can then divide the project into a number of tasks, each of which will be the subject of an individual work value. A work value should not be issued for less than a quarter of an hour or more than eight hours.

(2) The working methods to be followed in the execution of each task must be decided. This often calls for consultation with the craft foreman and may involve the use of method study.

(3) The estimator will then analyse each task into a number of elements or constituent parts. From consideration of its work content, the estimator will assess a time for the performance of each element. In doing this, he will make use as far as possible of synthetic data which has been prepared and tabulated from the results of time study observations.

(4) The times for the various elements are then aggregated, allowances for rest and personal needs are added and the resulting time becomes the standard time. Then a percentage, depending on the level at which bonus is to become payable, is added to give the allowed time or work value.

This procedure is recognised as the most satisfactory means of determining a performance level for incentive payment on plant maintenance.

### *Performance and Earning Relationships*

Before a bonus scale can be established, certain basic decisions have to be made by top level management in conjunction with the engineer responsible for installing the scheme.

(1) How much bonus shall be paid in return for the achievement of standard performance: that is, in return for carrying out tasks, on average, at the assessed times?

(2) At what level of performance shall bonus start to be paid?

(3) Over what period shall bonus earnings be calculated: weekly, daily, or for each separate task?

The conception of standard performance should be fairly high. It is the productivity expected from an experienced and skilled man working with consistent application and with optimum effort, speed, and attention. How much bonus shall be paid for this? At present wage levels the *minimum* weekly bonus would amount to 45% of 66s. (basic wage) that is, 30s.

For plant maintenance incentives, other than merit bonus, earnings should be calculated over the week by equating the hours worked against the hours gained as credits. As a hypothetical case, take the hourly bonus rate in return for achieving standard performance as nine pence per hour and assume that bonus starts at $\frac{100}{130}$ of standard performance. Allowed times are obtained, therefore, by adding 30 per cent to the standard times.

A man's actual weekly performance index can be expressed as a formula:

$$\frac{\text{Credit of allowed hours for the week}}{\text{Hours worked on bonus}} \times 100$$

The bonus scale becomes that given in the table, with interpolations as necessary.

| *Performance Index* | *Bonus Rate in Pence per Hour* |
|---|---|
| 100 | Nil |
| 110 | 3d. |
| 120 | 6d. |
| 130= standard performance | 9d. |
| 140 | 12d. |
| 150 | 15d. |

It must be emphasised that this performance-bonus earning scale is illustrative of one method only and must not be regarded as a recommendation for adoption in practice.

### *Necessity for Planning*

To be successful, an incentive scheme does involve thinking and planning ahead. Where capital extensions and additions are concerned, schedules of work should be prepared for the information of foremen and estimators. Such schedules are useful for progressing as well as for planning and work assessment. Overhauls and repairs should also be planned in three stages: (1) Withdrawal from service and dismantling for inspection. (2) Execution of repairs, reconditioning of parts, and fitting of replacements. (3) Re-assembly and re-erection.

The introduction of improved planning methods should reduce the time spent on attending to breakdowns to the very minimum.

Continuity of work must be ensured as it provides the largest source of saving and improved efficiency. The clerical routine requires a card, docket, or ticket to be prepared for each task by the estimator. A supply of tasks—complete with instructions, materials, and cards—must be held by the foreman ready for immediate issue to men. Proper organisation of the issue of work is an essential feature in any incentive application

# *Some Points about the Electricity Regulations*

## Part 3

by H. W. SWANN, O.B.E., D.F.H., M.I.E.E.

IN previous articles in this series I discussed the Factories Act 1937, and then went on to deal with the Electricity (Factories Act) Special Regulations 1908 and 1944. These Regulations open with a number of exemptions, the fourth of which says that nothing in them shall apply "to any process or apparatus used exclusively for electro-chemical or electro-thermal or testing or research purposes" provided suitable safety precautions are taken. Last month I discussed the electro-thermal, testing and research aspects of this exemption. Now I continue with electro-chemical applications.

I do not remember being concerned with proposals for higher voltage until the war years when I saw plans for a new aluminium smelting project for operation at 600 V. The earlier plants in Scotland and Wales worked at half this figure and although I appreciated that the floors would be dry and relatively non-conducting, I enquired about the possibility of anchoring the mid point of the 600 V series and thus halving the shock to earth value. In the event this was done, with a leakage indication connected at the mid point, and when I saw the plant in operation the workpeople I talked to smiled at my questions about electric shock. The plant engineer also smiled when I looked at the centrally disposed needle of the leakage indication but I have no reason to think it was not connected up. In this happy atmosphere I left the works having learned that the use of higher voltages in an aluminium producing furnace did not seem unduly dangerous. This experience has been confirmed in Scotland but I always hesitate to say too much about places where there has been no accident because fate can be so unkind.

In another project for the production of chlorine and soda by the electrolysis of brine the proposals were to operate at 700 V or more, using d.c. generators in series. American experience of accident-free operation at 800 V was quoted and as we seemed to have got on all right at 600 V for aluminium I did not think the terms of Exemption 4 precluded a somewhat higher figure provided the floor was made of some non-conducting material, and pipes for gas, water and brine, were insulated to prevent electric shock to earth. Previous experience of this particular sort of process, although at a much lower voltage and with mercury cells had not been attended by accident but when the new project got into production it was found difficult to maintain the insulation of the cement-formed cells and pipework because the degree of humidity and porosity was higher than was expected.

Where, as in some other plants, it has been possible to use glass cells, humidity has not proved to be so serious a factor. A reasonable degree of insulation has been achieved by wood floors and the idea of limiting shock voltage to earth by anchoring the mid-point of the series has been attempted by way of a rotary balancer. There is, however, a good deal of distributed leakage in these wet cell rooms and a small two-machine balancer, connected across the cell series with the mid-armature point earthed, may not be successful in securing firm anchorage although this is partially achieved.

A cell series designed to operate without intentional anchorage does in fact take up a fairly constant floating potential and if distributed leakage is uniform the mid-point of the series will approximate to earth potential. I have tried the effect of connecting artificial "earths" at end cells of a series under such conditions and found that, as might be expected, the other end goes up to full voltage from earth which is not reassuring. I am inclined to think also that under some conditions I have seen there must be a good deal of leakage current from cell to cell which is not electrolysing anything but the structural steelwork.

### *Cell Removal*

The fact that electrolytic processes, such as these, are continuous, means that operational work, renewals, and repairs have to be carried on whilst a cell series remains in service. Where safety depends on maintaining effective insulation of the workpeople from earth the plant engineers are called on to construct special lifting gear, such as cranes or trucks, for removing a cell from circuit without earthing the series or involving risk. A good many difficult problems have to be overcome, for instance—these big cells are heavy and the combined weight of a cell on its carriage causes the wheels of the latter to cut into the insulating

material covering the floor unless it is pretty hard stuff. Again it is far from easy to insulate pipework both to prevent it carrying current from the cells and prevent it from being touched. Glass pipes can be used for some of the jobs but the high temperature which prevails limits the use of materials other than steel for pipework and thus attempts have been made to introduce insulating linings into the latter.

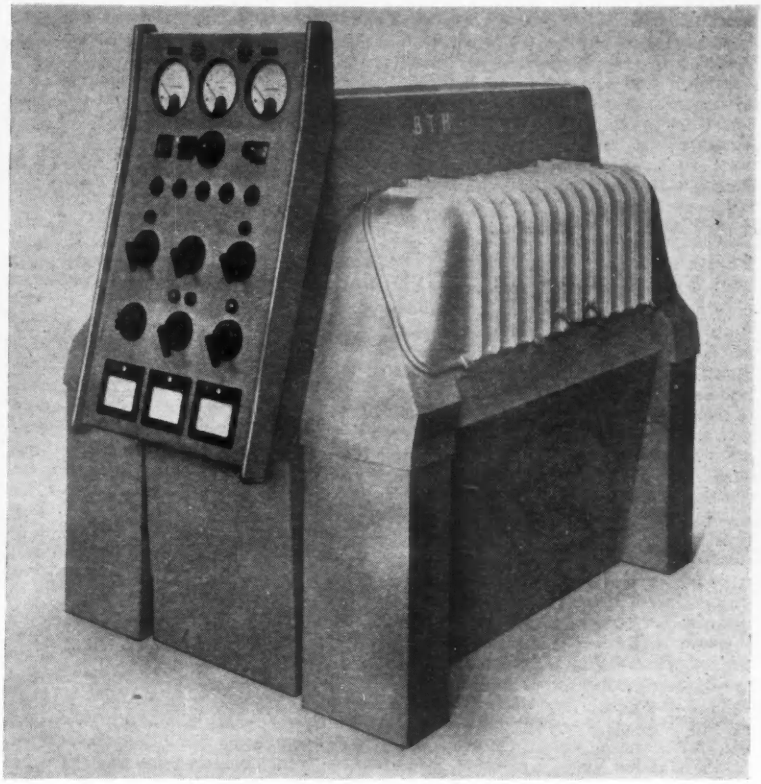
In processes using non-porous cells and therefore likely to be reasonably dry, there is more likelihood of success of an endeavour to insulate the steel structure of very large cell-rooms by resting the girders on insulating material and securing them with bushed bolts. A special type of glazed tile possessing high resistance and material strength can be used for the floors but much attention is still required for cell lifting appliances and the insulation of pipework.

There is just another point I should like to make in connection with high voltage electrolytic plant. The degree of insulation on which operational safety depends must be maintained during the life of the plant and the engineers concerned will find it necessary to establish this condition by regular tests and consequential action. There is not a great deal of past experience of high voltage working in this country and I hope that my friends who have the major responsibility of running the plants constructed in recent years will be fortunate, and remember me if it turns out well, but not otherwise.

### *Mechanical Rectifiers*

An alternative to high voltage working may lie in the use of the mechanical rectifier which is credited with an efficiency of 96% at say 200 V d.c. output and thus beats the mercury arc rectifier in that respect. When the Americans were looking around Germany just after the war was over, they found one, or more, of these machines of which the moving parts had been constructed in 1940, I believe, by a firm of automobile engineers. I am writing from memory of what I have been told about this but the rectifier has a resemblance to an engine with valve lifting gear. Perhaps a more important feature of this interesting machine is the use of special iron core chokes which, in association with a lot of other circuit control equipment, has the effect of flattening the alternating current curve just before it passes through the zero line and the contacts are timed to make or break away during this flat zero moment. The illustration shows a British model. (B.T.H.)

It seems likely that the initial cost of high voltage schemes, with that of subsequent maintenance, will in future planning be carefully weighed against those associated with mechanical rectification. If the machines are reliable, and not upset by supply system disturbances, their use at low voltage would represent a considerable saving of the costs of precautions otherwise implied under the terms of Exemption 4 of the Regulations.



*This machine is a British mechanical contact rectifier*

The last exemption, No. 8, which affects the application of the Regulations, was added in 1944. It was thought necessary because the Factories Act 1937 extended them to building operations, works of engineering construction, work on ships and other places where there might already be a permanent electrical installation in operation. For instance, if a shop or a block of offices is being enlarged, the Regulations apply to the builder and his work, and Exemption 8 is meant to stop them applying to the installation already in use in the original occupied part of the structure. In some cases an installation already in existence may be of help to a builder in giving him some light, or affording a source of power, and the idea of the exemption is to draw the line between the builder and the other man. But the exemption does not cover portable electrical apparatus, so if the other man lends the builder a hand drill for a job the Regulations apply and No. 13 says it must be "efficiently earthed." This is the reason why the exemption was not prepared to hold its umbrella over the hand drill, because there is a chance that the builder may not possess a 3-pin socket for the plug, or if he has, it may not fit, and again the builder's earth wire may not be "efficient," especially if it is twisted on a painted girder or a water pipe splashed by cement. Put another way, the builder cannot escape his legal obligation by borrowing the other man's hand drill to use instead of his own, and the other man will not be put under legal obligations just because he gives the builder a light.

ELECTRICITY REGULATIONS 1908 AND 1944.

EXEMPTION 8 (IN FULL)

Nothing in these Regulations shall apply to apparatus other than portable apparatus, forming part of the permanent electrical installation of a building, structure, ship or place by reason only that the apparatus, or the installation of which it forms part, is used for the lighting of any building operation or work of engineering construction or work in a ship to which the provisions of Section 105 (2) or Section 106 of the Factories Act, 1937, apply or for the supply of electrical energy for the purposes of any such operation or work.

Talking about builders leads me to mention what I call the "interregnum" between the time when the erection of a factory is finished and the time when it goes into production. The definition of a "Building Operation" [Section 152 (1)] covers laying the foundations, putting the building up, maintaining it, and at the last, knocking it down, but it says nothing about putting plant in. It is true that, under some circumstances, the installation of the machinery for production will begin before the building is finished, but installation work is not a "building operation" and thus regulations do not apply to it, or to the plant, until the latter makes something for the sales depart-

ment to sell. Most factory processes make the fullest possible use of electrical service, and thus much electrical plant, equipment and apparatus will be lifted in erected, tested and tried, generally whilst the place is full of contractors' workmen, and temporary wiring. Those who are familiar with these conditions usually agree that there is more risk of electrical accidents at such a time than is ever likely after production starts.

### *Three in One*

I saw a fairly simple illustration of the position in a hydro-electric station designed for three generators. The first machine had been put to work in a completed section of the power house, but building construction was still going on at the other end. In the middle the second generator was being erected, whilst outside they were laying big pipes for the supply of water to the position where the third turbine would be. As I understand the law (which is not often) the first section was an electrical station under Section 103, because the running machine was making electricity, the erection work on the second generator was not covered by the Act, but it applied by reason of Section 152 to the unfinished end of the building and because of the same section, but three pages further on, to the heavy pipe laying which constituted a "work of engineering construction." The turbine-house crane was of course in constant use along the whole of the building, and had the driver been a student of law he might have pondered as he drove in and out of the "factories."

Of course a lot depends on the point of view about the underlying purpose of the Factory Acts, and a Court seeking to give effect to this might decide that it protected all the men working in the various sections and passing from one to another. There has, however, been a decision, although not in the High Court, which emphasises the legal distinctions. In cases where very large manufacturing plants are under construction, the interregnum may last for a couple of years, and although the inspectors visit to investigate accidents, action is limited to offering advice. It is in fact often difficult to disentangle the various jobs to decide whether they are associated with building or plant, and it is just about at this time that the management is selecting the plant maintenance engineers' staff, who will be left to look after the new plant when everybody else has gone. They must find their first few days a little trying but, apart from the uncertainty about the application of regulations (which will not rank as the matter of highest importance in their minds), it is a very good thing for the practical maintenance men to see the equipment under construction, and to that extent the earlier they come on the scene the better —even without regulations to take care of them. They are the people who will have to start the wheels going round, and meet the complaints of the production department when they stop.

Anyone who has been in touch with these construction jobs all the time cannot fail to be impressed by the way that order is evolved from seeming chaos and when the law deems that it can make a dignified entry on the scene the dangers of childbirth are past. Perhaps, after all, it saves some embarrassment.

ELECTRICITY REGULATIONS 1908 AND 1944: REGULATION 1.

> All apparatus and conductors shall be sufficient in size and power for the work they are called upon to do, and so constructed, installed, protected, worked and maintained as to prevent danger so far as is reasonably practicable.

Regulation (1) is of a comprehensive character, in fact I have heard it said that its field is so wide that the other 31 clauses of the code need hardly have been written. I should think it was an afterthought, meant to cover anything that had been left out, and that it was put in front of all the rest to disguise the fact. If its object really was to fill in the gaps it achieves it admirably for it contains the only references in the code to three most important subjects—the *adequacy* of equipment, its *working* or operation, and its *maintenance*.

Curiously enough the question of adequacy, or as the regulation puts it "size and power," is probably of greater relevance in these later years than it was when the words were written in 1907. This is not to say that wires did not get hot or fuses blow up, but the margins were then more generous and the prospective fault energy very much lower. The "size," or more properly the cross sectional area of a conductor, would be determined at the time of installation by estimating the load and relating it to area by reference to the tables of the Wiring Rules. After the lapse of years, however, some uncertainty arises, except, of course, in well regulated establishments, because records may have been lost and load increased.

In the absence of records and circuit ammeters it is quite a job of work to find out the size of a conductor and measure its loading. I tried not so long ago to do it myself on a 50 year old installation, but I soon gave up attempts to see conductor ends by torchlight in distribution fuse boxes and I could find very few places where I could get a tong-tester over a wire. Connecting an ammeter across an empty fuse holder was a rather laborious job on a big installation and the ammeter wires, being outside the holders made it difficult to get the latter into the contacts which were shrouded. After trying to get a tong-tester to clasp a single fuse I gave it up before I had an accident. I found some warm cables and hot spots by feeling for them and I rather think this may be the method most commonly employed to assess the adequacy of conductors. In the event, I had to be content with accepting the ratings marked on the covers of some of the main circuit switches as an indicator of the "carrying" capacity of the conductors connected to them and I estimated the circuit loading by looking at the fuse wires and the state of the contacts.

When I have had occasion to look through consultants' reports on installations of this character, and contractors estimates for repairs and renewals, I have noticed that opinions as to the rewiring and replacements considered necessary are based on observation of what is visible rather than measurement, other than that of insulation resistance. An electrical inspector going round a factory reaches his conclusions in much the same way and I suppose that this is all that is "reasonably practicable" in the absence of records and some small convenient gadget for ascertaining circuit loading.

I have sometimes wondered how far the accepted practices of the day, in any particular aspect, have resulted from the availability of tools which made it possible. The walls of the Institution are graced by the portrait of a man who placed a tool for measuring insulation resistance in the hands of engineers who use it as a matter of course.

I have seen switches with blue contacts and distribution fuse boards with tea cans on top, but such conditions may be due to bad contacts rather than underrating, and anyway they are in sight. But hot wires under the floor are not so easily observable, and by the time they smell, damage may have been caused to the insulating coverings,

I have laboured this point, perhaps unduly, because I think it relevant to electrical fire risk which is increasing slowly but steadily every year. Most codes of regulations either in this country or abroad contain some reference to conductors being sufficient for the job, thus recognising the importance of the point, but subsequent checking of conditions by measurement may be justified as time goes on with changes of loading, if only to establish that they are satisfactory and that no expense need be incurred on renewals—and conversely.

One turns naturally from the adequacy of the wires and cables to that of the circuit protective devices which should operate if they are overloaded or become defective in their insulation. The question of the overload setting is related to what I have been trying to say above, but I am concerned at this point with the functional adequacy of fuses and circuit breakers—that is their ability to operate without distress under the conditions which obtain where they are used. I think it is true to say that, with ups and downs, the designs of automatic protective equipment has in general kept pace in this respect with the requirements of successive years. The little circular china pot container with an open fuse wire of my early days was then adequate for the fault energy conditions, but as the latter increased it had to give place to the bridge holder type which was not so likely to burn one's fingers if replaced on a fault. It was for this reason that the inspectors asked for switches in series, especially on switchboards, although this was rather an admission that the fuse construction could not be trusted and was therefore inadequate for purposes of the Regulations.

***(To be continued)***

# COMMERCIAL INFORMATION

## Contracts Open at Home . . .

*Dates given are the final for receipt of tenders, unless otherwise stated.*

**19 Mar.—Beccles T.C.** Lamps in year from 1 Apr.—See 11 Mar. issue.

**19 Mar.—Bromley T.C.** Rewiring St. Mark's school.—See 11 Mar. issue.

**19 Mar.—Nottingham T.C.** Improved lighting along trunk road A.614.—Advertised in 4 Mar. issue.

**20 Mar.—Amersham R.D.C.** Centrifugal pumps, electric motors, switchgear, etc., for Little Chalfont drainage scheme.—See 4 Mar. issue.

**20 Mar.—Golborne U.D.C.** Electrically driven water booster plant at Houghton Coat.—See 25 Feb. issue.

**20 Mar.—Hemel Hempstead T.C.** Lamps in fiscal year 1954-55.—See 11 Mar. issue.

**20 Mar.—Sutherland.** Installation in dwellings at Tongue and Bettyhill.—See 4 Mar. issue.

**20 Mar.—Sutton and Cheam T.C.** Reconstruction of Worcester Park sewage works, involving erection of 280 yd o.h. power line; 1,200 yd of underground power and lighting cables; supply of switchgear; final circuit wiring to 14 motors and equipment; lighting units; and overhaul of equipment. Names to Borough Engineer, Municipal Offices, High St, Sutton, by above date. Deposit £2. 2s.

**22 Mar.—The Dearne U.D.C.** Mercury vapour and fluorescent lighting along Claydon Lane and George St, Thurnscoe.—See 25 Feb. issue.

**22 Mar.—Maidstone T.C.** Installation in 88 flats on Shepway estate.—See 4 Mar. issue.

**22 Mar.—Manchester T.C.** Electrical installation in 14 shops and 244 dwellings at Middleton.—See 25 Feb. issue.

**22 Mar.—N. Ireland.** Installation in shops, flats and office at Portadown.—See 11 Mar. issue.

**22 Mar.—Yeovil T.C.** Steel columns, and lamps, for street lighting.—Advertised in 25 Feb. issue.

**23 Mar.—Arbroath T.C.** Electrical work in 34 flats and 14 shops in Seaton Rd.—See 11 Mar. issue.

**23 Mar.—Laoighis (Eire).** Installation in nurses' home at Port Laoighis.—See 11 Mar. issue.

**24 Mar.—Belfast.** Installation in St. Joseph's primary school, Slate St.—See 11 Mar. issue.

**24 Mar.—Harrogate T.C.** Lamps in year from 1 Apr.—See 4 Mar. issue.

**24 Mar.—Ilford T.C.** Pumps, motors and other equipment for sewage at pumping station.—Advertised in 4 Feb. issue.

**24 Mar.—Littlehampton U.D.C.** Installation in 30 houses on Wickbourne estate.—See 25 Feb. issue.

**24 Mar.—Luton T.C.** Installation in Farley school extension.—See 4 Mar. issue.

**26 Mar.—Belfast T.C.** Two sets of central evaporating plant for power station West.—Advertised in 28 Jan. issue.

**26 Mar.—Belfast T.C.** Automatic water jet fire fighting and alarm installation at power station West.—Advertised in 25 Feb. issue.

**26 Mar.—Belfast T.C.** L.T. switch-fuse distribution board.—Advertised in 4 Mar. issue.

**26 Mar.—Erpingham (Norf.) R.D.C.** Two electrically driven submersible type borehole pumps, etc., for Matlaske/Holt water supply.—See 4 Mar. issue.

**26 Mar.—Lees U.D.C.** Group B street lighting in Stamford Rd, and St. John St. Also in Spring Lane and Thomas St.—See 11 Mar. issue.

**26 Mar.—Liverpool.** Distribution supply services for mental deficiency colony at Greaves Hall, Banks.—See 11 Mar. issue.

**26 Mar.—N. Ireland.** Installation at Fever Hospital, Purdysburn. — See 11 Mar. issue.

**29 Mar.—Gravesend T.C.** Rewiring and equipment at Public Library.—Advertised in 11 Mar. issue.

**29 Mar.—Manchester T.C.** Installation in public wash-house, Openshaw.—Advertised in 4 Mar. issue.

**29 Mar.—Manchester T.C.** Installation at central stores, Newholme. — See 11 Mar. issue.

**29 Mar.—N. Ireland.** Electrical installation at Downshire Hospital, Downpatrick. F. W. Parkinson and Partners, consulting engineers, 6 Murray St, Belfast. Deposit £3. 3s.

**29 Mar.—Todmorden T.C.** Supply, erection etc. of street lighting by sodium vapour discharge lamps along Leeds-Halifax-Preston Rd. Borough Engineer, Municipal Offices. Deposit £2. 2s.—Advertised in this issue.

**30 Mar.—Godalming T.C.** Installation in 304 houses on Farncombe estate.—Advertised in 11 Mar. issue.

**30 Mar.—Southgate T.C.** Equipment for street lighting scheme. — Advertised in 11 Mar. issue.

**31 Mar.—Durham.** Electrical installations in Consett grammar, Newton Aycliff modern, Peterlee junior modern and Peterlee infants', Silksworth modern, and New Penshaw, schools. Names to G. R. Clayton, county architect, Court Lane, by above date.

**31 Mar.—Eire.** Installation of electrical services at Grangegorman mental hospital. Varming and Mulcahy, consulting engineers, 70 Merrion Sq South, Dublin. Deposit £5. 5s.

**31 Mar.—Huddersfield.** Renewal of electrical installation at Colne Valley and District Co-op. Federated Bakery Ltd. Company at 677 Manchester Rd, Milnsbridge, Huddersfield.

**2 Apr.—Monaghan (Eire).** Supply and erection of two electrically-driven pumping units with accessories for Glaslough water supply scheme. P. H. McCarthy and Son, consulting engineers, 26 Lr. Leeson St, Dublin. Deposit £3. 3s.

**3 Apr.—Eccles T.C.** Electrical installation in 306 dwellings on Brookhouse estate. Borough Engineer and Surveyor, Town Hall Annexe. Deposit £3. 3s.—Advertised in this issue.

**3 Apr.—Long Eaton U.D.C.** Sewage pumping machinery.—See 11 Mar. issue.

**3 Apr.—Newbury (Berks) R.D.C.** Wiring 210 council houses.—See 11 Mar. issue.

**3 Apr.—Newcastle-on-Tyne T.C.** Installation at Rutherford grammar school.—See 11 Mar. issue.

**5 Apr.—Birkenhead T.C.** Supply of centre lathe, radial arm drill, shaping and hack saw machines, steam cleaner, drill grinder, arc welder and electric test bench. Passenger Transport Dept., Laird St.

**5 Apr.—Newcastle-on-Tyne T.C.** Installation in N. Fawdon primary school.—See 11 Mar. issue.

**6 Apr.—Newcastle-under-Lyme T.C.** Street lighting installations in group A along two stretches of roads.—Advertised in 11 Mar. issue.

**7 Apr.—Co. Down.** Electrical installation at Cregagh New Clinic, Belfast. J. McCandless, consulting engineer, 18 Strangford Ave, Belfast. Deposit £3. 3s.

**8 Apr.—Southampton T.C.** Electrical installation at Shirley Transport Depot (stage 3). Apply to Borough Architect, Civic Centre, by 24 Mar. Deposit £5.—Advertised in this issue.

**9 Apr.—Belfast T.C.** Heating and ventilating plant for 33 kV switch-house at power station West.—Advertised in 4 Mar. issue.

## Your Queries Answered

*Readers are invited to make use of our free enquiry department which possesses wide resources including an index of trade information with over 100,000 entries*

***A Selection from the 112 queries answered this week***

**9 in. 6 watt fluorescent lamps,** makers of? M.E.C.—Longlamps Ltd., 24 Marshalsea Rd, S.E.1.

**"Cumberland" switchboxes,** makers of? G.E.C.L.—T.E.W. Sales Ltd., Cumberland St, Birmingham 4.

**"Fortic" double water tanks,** makers of? S.C.P.—Range Boilers Ltd., Bridge St, Stalybridge, nr. Manchester.

**"3M" recording tape,** makers of? C.A.—Minnesota Mining and Manufacturing Co., Ltd., Arden Rd, Adderley Park, Birmingham 8.

**"Russell Hobbs" coffee percolators,** address of? T.E.—Russell, Hobbs Ltd., 1 Bensham Lane, West Croydon.

**"Rotaflex" shades,** makers of? B.E.D.—Rotaflex (Gt. Britain) Ltd., 90 Regency St, S.W.1.

**"SnoWhite" clothes drying cabinets,** makers of? R.E.—J. Glover and Sons Ltd., 39 Groton Rd, S.W.18.

**"Xtraray" reflectors,** makers of? A.W.L.—These were made by Hagger and Hawes Ltd., City Rd, E.C.1, but we can find no trace of this concern at the present time.

**9 Apr.—Glasgow T.C.** Supply of electrical accessories for lighting dept., in year from 1 June. Lighting Dept., 20 Trongate.

**12 Apr.—Harwich T.C.** Five sets of sewage pumps, two comminutor sets and ancillary equipment at Fernlea Rd station.—See 4 Mar. issue.

**13 Apr.—Knaresborough U.D.C.** Supply and erection of 11 group B columns with mercury discharge lamps and control gear for part 2 of Meadowside scheme. Engineer and Surveyor, Knaresborough House.

**15 Apr.—Berwickshire.** Electrical work in new secondary school buildings, at Duns. Names by above date to County Clerk, County Bldgs, Duns.

**17 Apr.—Richmond (Yorks) R.D.C.** Supply and erection of electrically operated pumping plant in duplicate. Council's consulting engineer, A. Brooksbank, 14 The Exchange, Bradford. Deposit £3. 3s.

**21 Apr.—Fifeshire.** Installation in High School at Kirkcaldy.—See 25 Feb. issue.

**21 Apr.—Newcastle-on-Tyne T.C.** Supply and installation of laundry equipment for flats in Hindhaugh St site. City Architect, 18 Cloth Market.

**26 Apr.—Gateshead T.C.** Electrical installation in Leam Lane primary school. Applications by 29 Mar. to Borough Surveyor, G. F. Winters, Municipal Bldgs, Swinburne St. Deposit £2. 2s.—Advertised in this issue.

## . . . and Overseas

*Details of items marked* may be obtained on application to the Board of Trade, Lacon House, Theobalds Rd, W.C.1, quoting reference.*

**6 Apr.—Formosa.** Central Trust of China requires supply of total of 61 distribution transformers to various specifications. Trust is at 96 Po Ai Rd, Taipei, Taiwan. B.o.T. (Ref: ESB 6066/54).*

**22 Apr.—Egypt.** Construction of h.v. transmission lines and switch stations for feeding transformer stations of El Deshondi and other electrical pumping stations. Specifs. available from Commercial Counsellor, Egyptian Embassy. 75 S. Audley St, W.1, at £10. 5s. 2d.

**28 Apr.—Australia.** Supply of two metal clad, floor mounting, enclosed, 415 V distribution switchboards for each of Capricornia and Townsville Electricity Boards. Specif. 427. State Electricity Commission of Queensland, Scottish Union House, 127 Eagle St, Brisbane. Copy of specification at 10s. 6d. B.o.T. (Ref.: ESB 5376/54).*

**29 Apr.—Kuwait.** Supply, erection etc. of 11 kV metalclad switchgear for phase 2 of 11 kV distribution system. Dept. of Electricity, Govt. of Kuwait.—Advertised in 11 Mar. issue.

**29 Apr.—Kuwait.** Supply of 25 500 kVA 11/·433 kV power distribution transformers for phase 2 of 11 kV power distribution system. President of Dept. of Electricity, Govt. of Kuwait.—Advertised in 11 Mar. issue.

**6 May—Egypt.** Modification of switchgear at Mansourah substation and extension of h.t. network at Mansourah. Municipalities Admin., Ministry of Municipal and Rural Affairs, Kasr-el-Doubara Port Office, Cairo. £E3 per set. B.o.T. (Ref: ESB 5373/54).*

**19 May—Australia.** Supply of 11,000 V cable, 660 V cable, and 250 V control cable for Townsville Electricity Board. Specif. 403. State Electricity Commission of Queensland, Scottish Union Hse, 127 Eagle St, Brisbane, 10s. 6d. per copy. B.o.T. (Ref: ESB 5957/54).*

**10 June—Australia.** Supply of equipment for centralised control of consumer loading and street lighting for Sydney County Council, Queen Victoria Building, 457-79 George St, Sydney. Tender 1783. B.o.T. (Ref: ESB 6056/54).*

**13 June—New Zealand.** State Hydro-Electric Dept. invites tenders for supply of two 312·5 kVA auxiliary generating sets for Atiamuri power station. Deposit is £100 and bond £435. Documents at N.Z. Govt. offices in London.

**22 June—New Zealand.** State Hydro-Electric Dept., Wellington, are inviting tenders (No. 255) for manufacture and supply of ten single-phase, double wound transformer units, each 7,778 kVA, 11/127 kV, 50 c/s, outdoor type, oil immersed. Deposit £100. B.o.T. (Ref: ESB 5578/54).*

**Date not known—New Zealand.** Supply of three 23,334 kVA 220/11 kV transformer banks and spare unit for Atlantic hydro-electric power station. Specifications available from N.Z. Government Offices in London.

## PRICES of cable metals and other materials

***Figures quoted are the official prices ruling on Tuesday, 16 March***

| | £ per ton | Weekly change £ | Price last year £ |
|---|---|---|---|
| COPPER, standard class A (settlement) | 233 | −3 | 285 |
| ,, (3 months) | 224½ | −1½ | — |
| LEAD, refined pig, min. 99·97% purity (cash) | 85½ | −1½ | 90½ |
| ,, (3 months) | 83½ | −1½ | 87½ |
| TIN, refined, min. 99·75% purity (settlement) | 726 | +16 | 948½ |
| ,, (3 months) | 680 | −2½ | 940½ |
| ALUMINIUM, ingots 99·99·5% | 156 | — | 166 |
| ZINC, virgin, min. 98% purity (cash) | 73½ | +½ | 79½ |
| ,, (3 months) | 72½ | — | 79½ |
| RUBBER No. 1, RSS, spot (per lb) | 16½d. | +1/32d. | 21⅛d. |
| ,, c.i.f. basis, ports, May (per lb) | 16 5/16d. | +¼d. | 22d. |
| ARMOURING: | | | |
| Galv. Steel Wire (0·104 in.) | 52 | — | 51½ |
| Mild Steel Tape (0·014 in.) | 40½ | +½ | 39½ |

## Gazette Announcements

### COMPANIES ACTS

**Fleming Adnitt Co., Ltd.**, W. A. Wheatcroft, C.A., of 9 Norfolk Row, Sheffield, has been appointed liquidator by members.

**Mayfield Electrics Ltd.** Creditors asked to send particulars to liquidator, N. W. Osborne, C.A., 11-12 Finsbury Sq, E.C.2, by 25 Mar.

**Electromatic Bar Installations Ltd.** Last day of receiving proofs in respect of intended dividends. 25 Mar. Liquidator is Bernard Phillips, 74 New Cavendish St, W.1.

**Hockley Electric Motor and Engineering Ltd.** Resolution for voluntary winding-up passed at meeting on 6 Mar. Leonard D. Lopes, cert. acc., of 3 Lloyd Rd, Broadstairs, Kent, was appointed liquidator, and creditors should send particulars to him by 27 Mar.

**Pilmore-Bedford Refrigerators and Engineering Co., Ltd.** Meeting of creditors will be held at offices of A. C. Palmer and Co., C.A., 21 Knightsbridge, S.W.1, on 26 Mar., at 3 p.m., to receive liquidator's report.

**Pluscold Installations Ltd.** W. R. Gotch, cert., acc., of 135 Ainslie Wood Rd, Chingford, E.4, has been appointed liquidator.

**Watson and O'Connor Ltd.** Meetings of creditors and contributories will take place at Royal Station Hotel, York, on 23 Mar. at 11.30 a.m. and 12 noon respectively.

*Partnership Dissolved*

Partnership between **Bertram L. Woodward** and **Harry C. Woodward**, trading as Woodward Bros., electricians, at 21 Exeter Rd, Kidlington, Oxford, dissolved as from 1 Mar.

### BANKRUPTCY ACTS

*Bankrupt Discharged*

**Sydney I. Chapman**, of 103 Endsleigh Ct, W.C.1, trading as S. Chapman & Co., electrical agent, applied for discharge at Bankruptcy Court, Carey St, on 3 Mar. Receiving order made against him in November, 1952. Official Receiver said unsecured liabilities appeared to amount to £3,304. Assets realised £212 and dividend of no more than 1½d. in the £ could be expected. Mr Registrar Cunliffe granted discharge subject to suspension of one year.

*Release of Trustees*

**Brighton.** Alice E. Dalmon and Stanley J. Dalmon, trading as P. Dalmon and Sons, electrical engineers, at 60 Teville Rd, Worthing. Trustee, J. S. Bradley-Hole, cert. acc., 7 Old Steine, Brighton, released as from 11 Feb.

**Bristol.** Graham A. Phipps, electrician, trading at 51 Frampton Cres., Fishponds, Bristol. G. W. Sisman, Official Receiver, 26 Baldwin St, Bristol, the trustee, released as from 5 Mar.

**Colchester.** Clarence L. Philpott, radio and electrical dealer trading at 55 High St, Walton-on-Naze. Trustee, A. W. Hunter, cert. acc., 418-22 Strand, W.C.2, released from 20 Feb.

**Windsor.** Kenneth J. Ward, electrical contractor, trading as "Howard," Trusthorpe Rd, Sutton-on-Sea, Lincs. Trustee released from 1 Mar. He was C. T. Newman, Official Receiver, 58-61 York Terr, Regent's Park, N.W.1.

*Receiving Order*

**Chester.** W. J. Standing, electrician trading at 7 Brook St, Chester, Date of receiving order, 4 Mar.

# BUSINESS PROSPECTS

## Home

**Aberdeen.** Cohesion Ltd. propose to develop site of former Palace Hotel, comprising store, offices and covered car park.

**Aldridge (Staffs.) U.D.C.** Approval received for erection of public hall costing about £20,000.

**Antrim.** Ulster By-Products Ltd. are to erect factory at Glenary.

**Ashton - under - Lyne.** Expenditure of £137,950 has been approved for erection of Hartshead secondary school in Lees Rd.

**Barnet.** It is proposed to extend S. Herts College of Further Education at cost of about £57,300. Assembly hall to be built at Underhill school.

**Barnsley T.C.** Plans in hand for new Kendray secondary school, estimated to cost £215,000.

**Belfast T.C.** Amended plans approved for £400,000 swimming pool in Grove Shore Rd.

**Billericay U.D.C.** Tenders to be invited for erection of 18 houses and 16 bungalows at Laindon.

**Billingshurst (Sus.).** Plans approved for erection of 3-storey county secondary school. Cost estimated at £174,200.

**Bollington (Ches.) U.D.C.** It is proposed to erect 82 houses on Henshall Rd. site.

**Bootle T.C.** Construction of primary school in Copy Lane, Netherton. Borough Surveyor, Town Hall.

**Boreham Wood (Herts).** Sketch plans in hand for junior and infants' schools and health clinic at Leggetts Farm. Estimated cost £111,101.

**Burghfield (Berks).** Approval given to erection of secondary modern school, estimated to cost £104,143.

**Carlisle T.C.** Permission sought to include school building projects costing £221,175 in 1955-56 programme. They include Harraby secondary modern girls' school (£99,000), and Morton junior school (£51,000).

**Cheltenham (Glos) R.D.C.** Approval granted for construction of 146 houses at Churchdown and flats on Pound Farm estate, Brockworth.

**Crayford (Kent).** Approval received for first instalment of £114,000 Slade Green secondary school.

**Dublin T.C.** Erection of 130 houses on Ballyfermot estate. City Treasurer, Exchange Buildings, Lord Edward St.

**Durham.** Estimates include erection of two health centres costing £36,000 each; one will be at Newton Aycliffe. Ambulance station proposed at Hartlepool. Loan sanction for £178,124 received by R.D.C. for 32 houses at West Raintan, 34 at Kelloe and 78 at Bowburn.

**Eastbourne T.C.** Rewiring of Winter Garden has been proposed.

**Edinburgh.** Building programme approved which includes erection of 20 schools and additions to existing schools, estimated total cost of which is £980,000.

**Finchley T.C.** Showrooms and offices proposed by F. and H. Joyce Ltd., of 964 High Rd.

**Gateshead T.C.** Sketch plans approved for proposed Leam Lane infants' school and stage 1 of Hill Head secondary school. Regional Hospital Board proposes a chest clinic at Queen Elizabeth Hospital.

**Gillingham (Kent).** First instalment of £146,000 Great Lines secondary school has been approved.

**Glasgow T.C.** Construction of shops and maisonnettes in Fieldhead Sq., Eastwood. Architectural and Planning Dept., 20 Trongate.

**Grantham T.C.** Fifty-six houses and 16 bungalows to be built in Goldsmith Rd.

**Greenwich.** L.C.C. has approved plans for erection of St. Austin's R.C. boys' secondary school off Charlton Rd. Cost estimated at £169,971.

**Halifax T.C.** Erection of 68 flats at Mixenden and four in Moor Lane. Borough Engineer, Crossley St.

**Hereford T.C.** Tenders may soon be invited for erection of 76 houses on Tupsley estate and 22 on Hunderton estate.

**Heywood (Lancs.).** Plans submitted by J. Ingham for textile factory in Schofield Rd; and by Mutual Mills Ltd. for 2-storey office block.

**Hull.** Final plans approved for new Alderman Cogan secondary school which will cost about £100,941.

**Ilford.** Higgins and Thomerson, architects, 76 Finsbury Pav, E.C.2, have applied to erect 4-storey department store to replace existing premises in Station Rd.

**Kidsgrove (Worcs.).** Approval received by A. W. Hewetson Ltd. for proposed extensions to their factory.

**Lancaster T.C.** Application to be made to borrow £107,577 for erection of houses.

**Leicester T.C.** Erection of 3-storey shopping centre on Eyres Monsell estate, including 26 shops and 22 maisonnettes over. City Architect (Housing Section), Municipal Offices, Charles St.

**Lindsey.** C.C. approved erection of second instalment of N. Lindsey Technical College. Estimated cost £127,000.

**Longford (Eire).** Tenders to be invited for wiring of Ballinamuck Technical School.

**Mitcham (Sur.) T.C.** Scheme approved for development of Phipps Bridge area involving some 630 dwellings and a total cost of about £1,768,000.

**Motherwell.** Dean of Guild Court has approved plans for 695 houses on N. Forgewood site, Bellshill Rd.

**Newcastle-on-Tyne T.C.** Civil defence control centre to be built in Sackville Rd.

**Northwich (Ches.).** Planning permission granted to British Crepe Ltd. of Finney's Lane, Middlewich, for factory in Cumberland St.

**Prudhoe-on-Tyne U.D.C.** Plans submitted for erection of 105 houses at West Wylam.

**Scunthorpe.** T.C. seeking permission to prepare scheme for erection of municipal offices.

**Sevenoaks R.D.C.** It is proposed to build 88 houses at Westerham, 74 at Seal, 12 at Ide Hill, eight at Otford and four at Fordcombe this year.

**Smethwick.** Plans submitted for erection of factory in Oldbury Rd, for Pinfold and Parr Ltd., of Birmingham.

**Wrexham T.C.** Aston Grove estate is site for erection of 48 houses. Site works are out to tender.

## Overseas

**Burma.** Senior Research Officer, State Industrial Research Inst., University Estate, Rangoon, is interested in receiving quickly catalogues and price lists of high quality scientific and engineering instruments. A list of instruments is held by the B.o.T.'s Export Services Branch (Ref: ESB 4695/54).*

# TRADE NOTES

**New Depots.** Nettle Accessories Ltd., in conjunction with their parent company Aerialite Ltd., have opened a new depot at 19a and 19b Blythswood St, Glasgow, C.2. Telephone Central 2299.

The Belgian associates of Wild-Barfield Electric Furnaces Ltd.,—S.A. Wild-Barfield—have moved to larger premises at 62 Rue Ten Bosch, Brussels.

**New Factory.** Globelite Industries Ltd., have opened a new factory at Marsh Barton, Exeter.

**Egyptian Imports.** Permits for certain electrical machinery and industrial equipment, paid in sterling, will now be issued without having recourse to the Import Entitlement Account. This concession will apply to all countries (except West Germany, Belgium and Holland) not having payment agreements with Egypt.

**Change of address.** The Nottingham branch of Albion Electric Stores Ltd., is moving this month from 37a Stoney St to Bancroft's Factory, Roden St.

**Beama Contract Price Adjustment Formulæ.**—*For Electrical Machinery and Equipment.* For purposes of calculating variations in: (*a*) "Rates of Pay"—the rate of pay for adult male labour at 13 Mar., 1954, shall be deemed to be 141s. 6d.; (*b*) "Cost of Material"—the index figure for materials used in the Electrical Machinery Industry published in the Board of Trade Journal on 13 Mar., 1954, is 155·1

*For Turbo-Generating and Allied Plant.* For purposes of calculating variations in: (*a*) "Rates of Pay"—the rate of pay for adult male labour at 13 Mar., 1954, shall be deemed to be 141s. 6d.; (*b*) "Cost of Material"—the index figures published in the Board of Trade Journal on 13 Mar., 1954, are: Materials used in Mechanical Engineering Industries—146·3; "Blast Furnaces and Iron and Steel Melting and Rolling (40 and 41)"—142·9; The price of brass condenser tubes, ¾ in. o/d, 18 s.w.g. published in *The Metal Bulletin* on 12 Mar., 1954, is 3s. 5¾d. per lb.

*For outstanding Contracts covered by the B.O.T. Intermediate Products Index.* For purposes of calculating variations in (*a*) "Rates of pay"—the rate of pay for Adult male labour at 13 Mar., 1954, shall be deemed to be 141s. 6d.; (*b*) "Cost of Material"—the index figure for Intermediate Products published in the Board of Trade Journal on 13 Mar., 1954, is 349·7.

## TRADE MARKS

*This information is extracted from the Official Journal by permission of the Controller.*

**Egen.** B721,028. Class 9. Potentiometers, volume controls, etc. Egen Electric Ltd., Charfleet Industrial Estate, Canvey Island, Essex.

**Matelux.** 725,773. Class 9. Photographic dark room lamps. 725,774. Class 11. Lamps. J. M. Wotherspoon and Co., Ltd., 194/200 Bishopsgate, E.C.2.

**Medelec.** 726,039. Class 11. Electric light fittings. Moore and Partners (Eng.) Ltd., 3 Devonshire Grove, Old Kent Rd, S.E.15.

**Thorn Electrical Industries Ltd.** 644,048. Class 11. Lighting apparatus. Thorn Electrical Industries Ltd., 105/109 Judd St, W.C.1.

**Wireohms.** 705,692. Class 11. Thermoelectric heating elements. Wireohms Ltd., Peas Hill Rd, Nottingham.

## Contracts Placed

**Barrow-in-Furness T.C.** Electrical installation in 64 small flats, N. Carradus, £1,784.

**Chesterfield T.C.** Electrical installation in Dunston county primary junior school, A. F. Parsons Ltd.

**Eston U.D.C.** Supply and erection of additional street lighting units, General Electric Co., Ltd., £2,039.

**Liverpool T.C.** Generating plant for emergency supply for C.D. sub-control centres, R. A. Lister and Co., Ltd., £2,173.

## MEETINGS TO NOTE

**THURSDAY, 18 MAR.**

I.E.E. (London Utilisation).—Discussion on "Training and Responsibilities of Marine Electrical Engineers," G. O. Watson. Savoy Place, W.C.2, 5.30 p.m.

I.E.E. (Mersey and N. Wales).—Dinner-dance at Hulme Hall, Bolton Rd, Port Sunlight, 7 p.m.

I.E.E. (Irish).—Electrical Requirements of Hospitals," R. J. Flood. Trinity College, Dublin, 6 p.m.

I.E.S. (Bradford).—"X-Rays," E. Hudson. Elect. Offices, Sunbridge Rd, 7.30 p.m.

E.A.W.—Film show at Assoc. H.Q. 2.15 p.m.

**FRIDAY, 19 MAR.**

I.E.E. (Rugby).—Annual Ball (with Rugby Engineering Soc.) at Chesford Grange Hotel, Kenilworth, 8.15 p.m.

BRITISH REFRIGERATION ASSOC.—Annual luncheon at Connaught Rooms, Gt. Queen St, W.C.2, 12.30 p.m.

**MONDAY, 22 MAR.**

I.E.E. (London Radio).—"Colour TV," C. J. Hirsch. Savoy Place, W.C.2, 5.30 p.m.

I.E.E. (N. Eastern).—"Kemano Hydro-Electric Development and Kitimat Aluminium-Reduction Works," F. L. Lawton, Neville Hall, Westgate Rd, Newcastle, 6.15 p.m.

I.E.E. (S. Midland Radio).—"Design of V.H.F. Mobile Radio Systems," E. P. Fairbairn. James Watt Memorial Inst., Gt. Charles St, 6 p.m.

I.E.E. (Western Utilisation).—"Artificial Respiration," C. E. Dew. S. Wales Inst. of Engrs., Park Place, Cardiff, 7 p.m.

I.E.S. (Birmingham).—"Stage Lighting from Producer's Viewpoint," Norman Leaker and Arthur Taylor. Crescent Theatre, 6 p.m.

I.E.S. (Leeds).—Annual meeting. Film on Glass Manufacture. 24 Aire St, 6 p.m.

I.E.S. (Leicester).—"Glass in Lighting Industry," J. G. Holmes. Elect. Offices, Charles St, 7.30 p.m.

JUNIOR INSTN. OF ENGINEERS (N. Western).—"Developments and Future Possibilities in Electricity Generation," Sir John Hacking. Engineers' Club, Albert Sq, Manchester, 7.30 p.m.

**TUESDAY, 23 MAR.**

I.E.E. (London Educ.).—"Experimental and Theoretical Approach to Teaching Electromagnetism using Rationalised M.K.S. System of Units," F. A. Meier. Savoy Place, W.C.2, 6 p.m.

I.E.E. (N. Midland).—Discussion on "High Voltage in Theory and Practice," A. R. Rumfitt. Bradford Tech. College, Gt. Horton Rd, 6.30 p.m.

I.E.E. (N. Western).—Faraday lecture on "Electro-Heat and Prosperity," O. W. Humphreys. Free Trade Hall, Manchester, 7.30 p.m.

I.E.E. (Rugby).—Annual meeting. "Development and Application of Nuclear Reactors," R. V. Moore. College of Technology and Arts, 6.30 p.m.

I.E.S. (London).—"Descriptions of New Lighting Installations." 2 Savoy Hill, W.C.2, 6 p.m.

BRITISH INSTN. OF RADIO ENGRS. (W. Midlands).—"Industrial Application of Electronic Instruments," A. G. Wray. Technical College, Wulfruna St, Wolverhampton, 7.15 p.m.

INST. OF FUEL.—"Solar Energy for Water- and Space-Heating," Dr H. Heywood. Instn. of Mechanical Engrs., Storey's Gate, S.W.1, 5.30 p.m.

**WEDNESDAY, 24 MAR.**

I.E.E. (London Supply).—"Cathode-Spot Performance Phases and Control of Mass Transfer in Vapour-Discharge Devices," H. von Bertele. Savoy Place, W.C.2, 5.30 p.m.

I.E.E. (N. Scotland).—"Development of Improved Methods of Earthing, especially in N. of Scotland," J. W. Tolmie and A. Mackenzie. Caledonian Hotel, Inverness, 7.30 p.m.

I.E.E. (S.W. Scotland).—"Arcs and Sparks," Prof F. Llewellyn-Jones. 39 Elmbank Cresc, Glasgow, 7 p.m.

I.E.E. (Southern).—"Royal Festival Hall: Electrical Installation," J. G. Hunter. R.A.E. Tech. College, Farnborough, 7.30 p.m.

JUNIOR INSTN. OF ENGINEERS (Midland).—"Choice of Electric Motor Control," J. R. Bell. Stewarts and Lloyds Ltd.'s Lecture Room, Bilston, 7 p.m.

**THURSDAY, 25 MAR.**

I.E.E. (London).—"Kemano Hydro-Electric Development and Kitimat Aluminium-Reduction Works," F. L. Lawton. Savoy Place, W.C.2, 5.30 p.m.

I.E.E. (Mersey and N. Wales).—Faraday lecture "Electro-Heat and Prosperity," O. W. Humphreys. Philharmonic Hall, Liverpool, 6.45 p.m.

E.P.E.A. (Merseyside).—"Economy in Choice of Switchgear," L. J. Bamber. Elect. Showrooms, Whitechapel, Liverpool, 7 p.m.

**FRIDAY, 26 MAR.**

I.E.E. (N. Eastern).—Annual dinner and dance at Old Assembly Rooms, 7 p.m.

I.E.E. (N. Midland).—Annual dinner and dance at Grand Hotel, Harrogate, 7 p.m.

I.E.S. (Bath and Bristol).—"Hospital Lighting," D. J. Reed. Elect. Offices, Colston Ave, Bristol, 6.15 p.m.

MANCHESTER ASSOC. OF ENGRS.—Annual meeting. "Engineering Aspects of Glass," Dr R. E. Bastick. Engineers' Club, Albert Sq, 6.45 p.m.

INCORP. PLANT ENGINEERS. (Birmingham).—Annual meeting. "Industrial Electrical Maintenance," D. Parkes. Imperial Hotel, 7.30 p.m.

## NEW COMPANIES

*Extracted from the Register issued by Jordan and Sons, Ltd., 116 Chancery Lane, W.C.2.*

**Bootle Bros., Ltd.,** 109 Bramblewood Close, Carshalton, Surrey. Electrical contractors and engineers, electronic, radio and television engineers, etc. Nom. cap.: £2,000. Dirs.: D. T. Bootle and R. G. Bootle.

**A. V. Cotty and Co., Ltd.,** Lloyds Bank Chambers, Caerphilly. Dealers in and manufacturers of artificial lighting apparatus, electrical plant, machinery. Nom. cap.: £10,000. Dirs.: A. V. Cotty and Mrs. E. D. Cotty.

**Electric Aids Ltd.,** 72 Cape Hill, Smethwick, Staffs. Manufacturers of and dealers in wireless goods, radio receivers and transmitters, television sets, etc. Nom. cap.: £100. Permt. dirs.: V. J. Hadley and N. C. Hadley.

**Essard Ltd.** Designers and manufacturers of and dealers in ovens fired by gas, oil, electricity or solid fuel, and all other machinery used in baking, cooking, serving and preparation of food, etc. Nom. cap.: £4,000. Dirs. not named. Subs.: H. I. Arnold, 15 Campden St, W.8, and M. M. Essex, 292 Westbourne Grove, W.11.

**Evans Electrical Appliances (Birmingham) Ltd.,** Evonic Works, 2a Birchfield Rd, Birmingham 19. Nom. cap.: £500. Dirs.: S. Cutler, R. S. and K. W. Evans.

**Glanvill Brown Ltd.,** 9 Cavendish Sq, W.1. Electrical and mechanical engineers, manufacturers of and dealers in dynamos, motors, etc. Nom. cap.: £100. Dirs.: C. Glanvill Brown and A. Glanvill Brown.

**Harmo Export Ltd.,** 56 Conybere St, Birmingham 12. Manufacturers of and dealers in motor vehicle accessories and component parts, and general, electrical and mechanical engineering products, etc. Nom. cap.: £1,000. Dirs.: J. W. Hartley, J. J. Mould and F. L. Mould.

**A. Lees (Salford) Ltd.,** 30 Swinton Park Rd, Salford. Papermakers' engineers, general, precision, mechanical, motor, aeronautical, electrical and constructional engineers, etc. Nom. cap.: £1,500. Dirs.: A. Lees, J. W. P. Lees and W. H. Andrew.

**Leisure Hours and Co., Ltd.,** Cary Chambers, Cary Green, Torquay. To take over business of manufacturers and factors of hobbies and model and experimental engineering and electrical units carried on as "Leisure Hours and Co." at 7a Totnes Rd, Paignton, Devon, by Leslie G. Butterfield. Nom. cap.: £2,000. Permt. dirs.: L. G. Butterfield, S. H. Reeves and P. J. H. Hill.

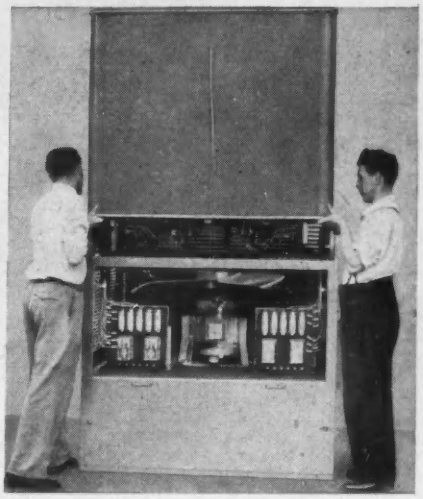
**Marco Tawil Ltd.,** 11 Albert Sq, Manchester. Nom. cap.: £2,000. Manufacturers and merchants of and dealers in motor car lamps, electric bulbs, clocks, mats and rugs, etc. Dirs.: M. Tawil and Blanche M. Tawil.

**Pakes and Co., Ltd.** Electrical and lighting equipment manufacturers, lighting consultants, etc. Nom. cap.: £100. Dirs.: R. C. Pakes, 60 Langler Rd, N.W.10 and L. G. Pakes, 128 North Circular Rd, Stonebridge, N.W.10.

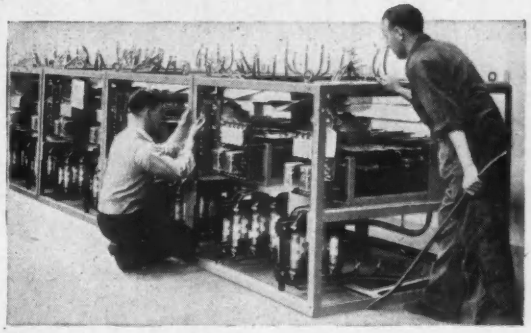
**Frank Whitelegg Ltd.** To take over business of engineer carried on at 11-13 Regent Parade, Sutton, Surrey, by Frank Whitelegg, mechanical and electrical engineers, etc. Nom. cap.: £2,000. Dirs.: F. Whitelegg, P. F. Whitelegg and Hedy Whitelegg, address not stated.

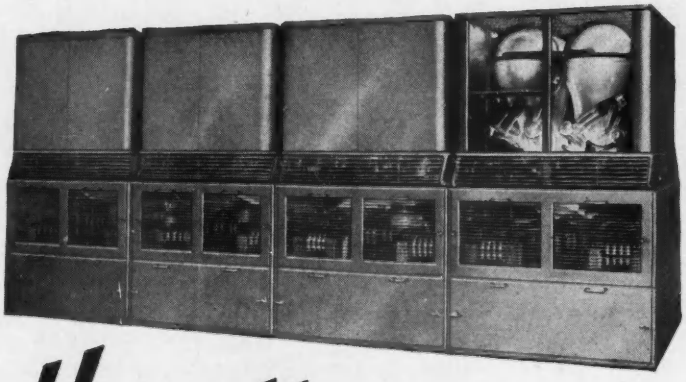
# Even greater advantages with the NEW Hewittic Rectifier type GT.

patent pending



- Unit components throughout giving greater interchangeability.
- Low base construction for easy manœuvring to site.
- Lightweight, streamlined bulb cradles affording maximum air flow past bulbs.
- Utmost ease of installation.
- Modern appearance—robust construction.





★ With these advantages Hewittic Rectifiers combine simplicity, reliability, and long service even under the most arduous conditions.

The illustrations show: *top*, lifting the cradles on to the base; *centre*, lining up the bases; and *left*, part of an order for 117,500 kW of Hewittic GT rectifiers for heavy duty traction service.

## Hewittic A GREAT NAME IN Rectifiers

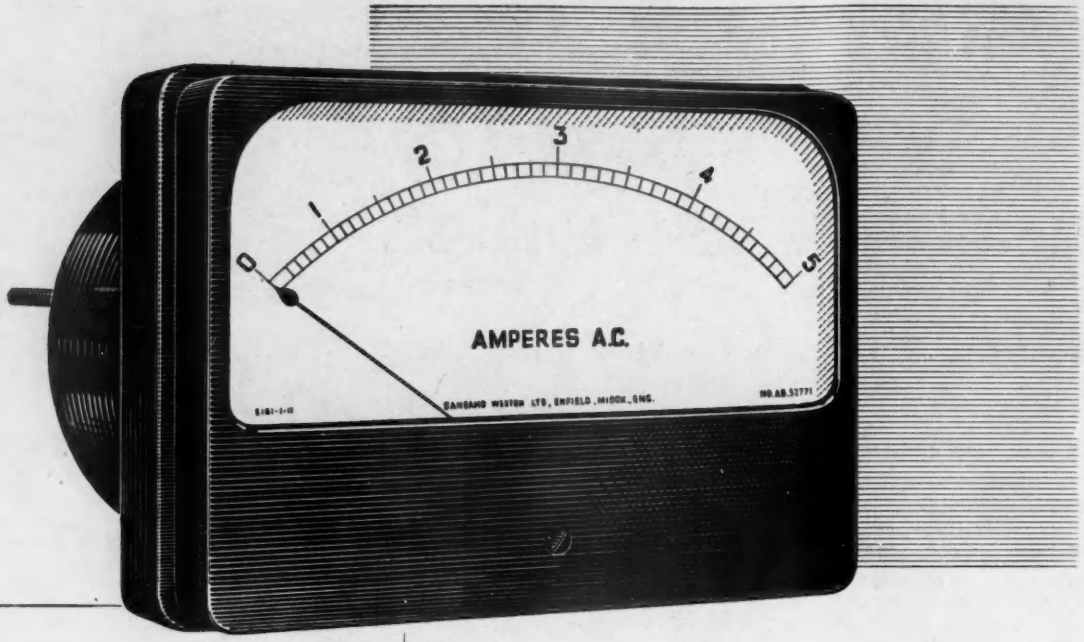
★ *Over 1¼ million kW in World-wide service*

**HACKBRIDGE AND HEWITTIC ELECTRIC CO., LIMITED**
**WALTON-ON-THAMES - SURREY - ENGLAND**

*Telephone : Walton-on-Thames 760 (8 lines)* *Telegrams : "Electric, Walton-on-Thames"*

**OVERSEAS REPRESENTATIVES**

ARGENTINA: H. A. Roberts & Cia., S.R.L. Buenos Aires. AUSTRALIA: Hackbridge and Hewittic Electric Co., Ltd., Sydney. BELGIUM & LUXEMBOURG: M. Dorfman, 124, Avenue des Cerisiers, Woluwé 1, Brussels. BRAZIL: Oscar G. Mors, Caixa Postal 1280, Sao Paulo. CANADA: The Northern Electric Co., Ltd., Montreal, etc. CHILE: Ingenieria Electrica S.A.C., Santiago. EAST AFRICA: Gerald Hoe & Co., Private Bag, Nairobi. EGYPT: Giacomo Cohenca Fils, S.A.E., Cairo. FINLAND: Sähkö- ja Koneliike O.Y. Hermes, P. Esplannaadikatu 37, Helsinki. HOLLAND: J. Kater E.I., Ouderkerk a.d. Amstel, Amsteldijk Noord 103e. INDIA: Steam & Mining Equipment (India), Ltd., Calcutta; Easun Engineering Co., Ltd., Madras, 1. IRAQ: J. P. Bahoshy Bros., Baghdad. MALAYA & SINGAPORE: Harper, Gilfillan and Co., Ltd., Kuala Lumpur. NEW ZEALAND: Richardson, McCabe & Co., Ltd., Wellington, etc. PAKISTAN: James Finlay & Co., Ltd., Karachi. TRINIDAD & TOBAGO: Thomas Peake & Co., Port of Spain. TURKEY: Dr. H. Salim Oker, Karanfil Sokak 59, Ankara. URUGUAY: H. A. Roberts & Cia., S.A.U., Montevideo. U.S.A.: Electro Machinery Corporation, 50, Broad St., New York, 4.




**WESTON ELECTRICAL INSTRUMENTS INCLUDE:–**

**LABORATORY STANDARDS**

**SUB STANDARDS**

**FIRST GRADE PORTABLE INSTRUMENTS**

**ROUND, RECTANGULAR AND EDGEWISE SWITCHBOARD AND PANEL INSTRUMENTS**

**PORTABLE TEST SETS**

**RELAYS**

**AIRCRAFT INSTRUMENTS**

# THE WESTON RANGE OF RECTANGULAR INSTRUMENTS

These instruments, giving the advantage of long, easily read scales, are designed to harmonize with rectangular panels and are offered in a variety of types and scale ranges.

Supplied as D.C. moving coil, A.C. rectifier and H.F. thermocouple types; also A.C./D.C. moving iron types. Four sizes are available with scale lengths of 2·5″, 3·2″, 4·2″ and 6·25″.

Front of panel or back of panel mounting may be adopted as desired and if the former method is used, there is complete interchangeability with existing round models. The 3·2″ and 4·2″ scale instruments are available with either illuminated or non-illuminated dials; the 2·5″ and 6·25″ scale instruments being available only with non-illuminated dials.

# WESTON

## Measuring Instruments

**SANGAMO WESTON LIMITED**
**ENFIELD · MIDDLESEX**
**Tel: Enfield 3434 (6 lines) & 1242 (6 lines) Grams: Sanwest, Enfield**

Scottish Factory: Port Glasgow, Renfrewshire. Port Glasgow 41151
Branches: London, CHAncery 4971 · Glasgow, Central 6208 · Manchester, Central 7904 · Newcastle-on-Tyne, Newcastle 26867 · Leeds, Leeds 30867 · Liverpool, Central 0230 · Wolverhampton, Wolverhampton 21912 Nottingham, Nottingham 42403 · Bristol, Bristol 21781 · Southampton, Soton 3328 · Brighton, Brighton 28497

# CLASSIFIED ADVERTISEMENTS

Advertisements should be sent to the Classified Advertisement Dept., Electrical Times, Sardinia House, Sardinia Street, London, W.C.2, before 10 a.m. on TUESDAY of the week of issue. Official Displayed Advertisements are charged at 32s. 6d. per inch, and all other classified advertisements at 2s. 6d. per line. Situations Wanted four insertions at twice the single insertion rate. Fee for Box Number and postage on replies 2s.

## TENDERS INVITED

### BOROUGH OF TODMORDEN

**Leeds—Halifax—East of Preston Trunk Road. Installation of Lighting by Sodium Vapour Discharge Lamps**

TENDERS are invited for the following works. The supply, erection and putting into service of a system of 59—140 W lighting units on Halifax Rd and 88—140 W lighting units and 2—60 W lighting units on Burnley Rd. The 140 W units to be mounted on steel columns with brackets and the 60 W units to be hung from the soffit of an overbridge.

Tenders may be submitted as follows:

(*a*) Supply of electrical equipment.

(*b*) Supply and erection of steel columns and brackets, together with the fitting and wiring of electrical equipment offered under (*a*).

(*c*) Supply and erection of steel columns and brackets, together with the fitting and wiring of electrical equipment offered by another firm.

Firms may tender for section (*a*) or (*c*) only or any suitable combination of sections.

General Conditions of Contract, Specifications, Bills of Quantities and Form of Tender may be obtained from the Borough Engineer, Municipal Offices, Todmorden, on receipt of a deposit of 2 guineas and plans of the scheme may be inspected at his office, during normal office hours.

Tenders in a plain sealed envelope, endorsed "Trunk Road Lighting," should be delivered to me not later than the first post on Monday, 29 Mar., 1954.

J. D. MOYS,
Town Clerk.

Municipal Offices,
Todmorden.
15 Mar., 1954. (H 241)

### BOROUGH OF NEWCASTLE-UNDER-LYME

TENDERS are invited for the following separate contracts for the installation of Group "A" lighting.

*Contract No.* 4.

Dimsdale Parade, Alexandra Rd, Jubilee Rd, Basford Park Rd, route No. B.5369 (approximate length 2 miles).

This contract is for the supply and installation of lanterns, lamps, control gear and concrete standards, the type of lighting specified being 140 watt Horizontal Burning Sodium Vapour Discharge Lamps.

*Contract No.* 5.

Sandy La and Albert St, Brook La, Friar St, Blackfriars Rd, Newcastle and London Rd and Wolstanton Rd, Chesterton, the total length being 1¼ miles.

This contract is mainly for the installation only of equipment which has been held in stock by the Corporation, comprising steel columns, lanterns, lamps and control gear previously supplied by the British Thomson-Houston Co., Ltd., but some new equipment will be required.

The type of lighting specified is 400 and 250 watt h.p. Mercury Vapour Discharge lighting.

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Plans may be inspected and tender documents obtained from the Borough Engineer, Lancaster Building, High St, Newcastle, Staffs. Deposit £2.

Tenders must be endorsed with the appropriate Contract number, and must be received by me not later than the first post on Tuesday, 6 Apr., 1954.

C. J. MORTON,
Town Clerk.

District Bank House,
Penknull St,
Newcastle, Staffs. (H 197)

### COUNTY BOROUGH OF GATESHEAD

**Leam Lane Primary School**

APPLICATIONS are invited from Contractors desirous of Tendering for the ELECTRICAL INSTALLATION to the above, in accordance with the Scheme and Specification prepared by the Consultants, Messrs R. W. Gregory and Partners, Newcastle upon Tyne.

Copies of drawings, Specification, and Form of Tender, may be obtained, and the General Conditions of Contract inspected, at the office of the Borough Surveyor, Municipal Buildings, Swinburne St, Gateshead 8, on deposit of Two Guineas, which will be refunded on receipt of a bona fide Tender or the return of the Drawings and Specification.

The Contract for the above work will form a sub-contract to the Main Building contract, and the Sub-contractor will be required to enter into a Bond with the General Contractor and the Corporation.

Applications to tender should be made to Mr G. F. Winters, B.E., A.M.I.C.E., Borough Surveyor, Municipal Buildings, Swinburne St, Gateshead 8, not later than Monday, 29 Mar., 1954, and Tenders returned on the official form in the endorsed envelope supplied, by noon on Monday, 26 Apr., 1954.

The lowest or any tender will not necessarily be accepted.

J. W. PORTER,
Town Clerk.

Town Hall,
Gateshead 8.
15 Mar., 1954. (H 239)

### BOROUGH OF ECCLES

**Brookhouse Estate Pt. 1—Electrical Installation**

THE ECCLES CORPORATION invite Tenders for the complete Electrical Installation in 306 Dwellings now in course of erection on the above Estate.

Plans may be seen, and Specification, Bills of Quantities and Form of Tender obtained on application to the Borough Engineer and Surveyor, Town Hall Annexe, Eccles, on payment of a deposit of £3. 3s. which will be returned on receipt of a bona fide tender.

Tenders, sealed and endorsed "Tender for Electrical Installation, Brookhouse Estate Pt. 1," must reach the undersigned not later than 10 a.m. on Saturday, 3 Apr., 1954. Envelopes must not bear any name or mark indicating the sender.

The Corporation do not bind themselves to accept the lowest or any tender.

G. O. JONES,
Town Clerk.

Town Hall, Eccles.
12 Mar., 1954. (H 240)

### SOUTHAMPTON C.B.C.

INVITES Tenders from Electrical Contractors for Shirley Transport Depot Stage 3—Electrical Installation to be Sub-Contract with Main Contractor (R.I.B.A. Contract plus Supplemental Conditions available for inspection). Forms and particulars from Borough Architect on £5 deposit by 24 Mar., 1954, refunded on receipt of bona fide Tender not subsequently withdrawn, or return of documents. Tender to the Borough Architect, Civic Centre, Southampton, by 10 a.m. on 8 Apr., 1954. (H 206)

## APPOINTMENTS VACANT

*Engagement of persons must be made through a Local Labour Office or Scheduled Employment Agency, if the applicant is a man aged* 18–64, *or a woman aged* 18–59; *unless the person concerned is excepted or the employment is in a managerial or professional capacity, or is otherwise excepted from the provisions of the Notification of Vacancies Order,* 1952.

### MIDLANDS ELECTRICITY BOARD

APPLICATIONS are invited for the following superannuable posts:

GENERAL ASSISTANT DISTRICT ENGINEER
LICHFIELD DISTRICT
WOLVERHAMPTON AND DISTRICT
SUB-AREA

Experience necessary in all branches of distribution work including routine testing and maintenance of Sub-Station plant, Transformers, Switchgear and Protective equipment. Technical qualifications desirable. Salary £433/£442 per annum (N.J.B. Grade D.13). Apply, in writing, within 14 days, stating age, qualifications, present position and salary to Sub-Area Manager, Midlands Electricity Board, 83 Darlington St, Wolverhampton.

JUNIOR ENGINEERS (THREE)
METER DEPARTMENT
SOUTH STAFFS AND NORTH WORCS
SUB-AREA HEADQUARTERS

Duties will include laboratory work, substandard instrument calibration, the testing of polyphase metering equipment both in the Test Room and on consumers' premises, and the carrying out of special tests on other apparatus including switchgear and relays. Technical qualifications desirable. Salary within the range of £402/£547 per annum according to experience (N.J.B. Grades M.21(3)/M.17(3)). Apply, in writing, within 14 days stating age, qualifications, present position and salary to Sub-Area Manager (Ref. CW). Midlands Electricity Board, Toll End Rd, Tipton, Staffs.

SUB-AREA SENIOR DEMONSTRATOR (FEMALE)
WORCESTER AND DISTRICT SUB-AREA

Applicants must have had a good education with training in Domestic Science, and should hold the E.A.W. Diploma. Duties include Lecture Demonstrations on all types of Domestic Appliances, advice to consumers on the selection and use of equipment, recruitment, training and supervision of staff and contacts with Educational Authorities and Women's Organisations. Salary £545/£605 per annum (N.J.C. Grade 3). Apply, in writing, within 14 days, stating age, qualifications, present position and salary to Sub-Area Manager, Midlands Electricity Board, Whittington, Worcester.

A. STEPHENS,
Secretary.
(H 210)

### BRITISH ELECTRICITY AUTHORITY

**Midlands Division**

JUNIOR ENGINEER is required at Ironbridge Power Station. N.J.B. service conditions, superannuable appointment, salary within Schedule "A," Grade H17 to H14, commencing at £402 per annum.

Applicants should have received a thorough technical education and practical training, and should preferably possess the Higher National Certificate in electrical engineering.

Apply on form AE6, quoting vacancy No. 629MD, available from the Establishments Officer, 53 Wake Green Rd, Moseley, Birmingham 13, by 3 Apr., 1954. (H 212)

## YORKSHIRE ELECTRICITY BOARD

No. 5 (WAKEFIELD) SUB-AREA
THIRD ASSISTANT ENGINEER
(DISTRIBUTION DESIGN)

APPLICANTS must have had practical experience in the construction, maintenance and operation of E.H.V. and M.V. distribution systems. Preference will be given to those having planning and estimating experience of urban and rural distribution networks.

Salary—N.J.B. Class K, Grade 9, £766/£796 per annum.

Applications, giving full details of age, qualifications and experience, together with the names of two referees should be forwarded to the Manager, No. 5 (Wakefield) Sub-Area, Yorkshire Electricity Board, 1a Denby Dale Rd, Wakefield, not later than 1 Apr., 1954.

No 2 (HUDDERSFIELD) SUB-AREA
THIRD ASSISTANT ENGINEER
(RURAL DEVELOPMENT)

Applicants should preferably be Corporate Members of the Institution of Electrical Engineers or hold equivalent qualifications. A knowledge of load development in Rural practice is essential and in Commercial and Industrial practice an additional qualification. Candidates must have a thorough knowledge of all farm electrical appliances and the successful applicant must be capable of putting a sales and service policy into active effect.

Salary—N.J.B. Class K, Grade 10, £719/£750 per annum.

Applications, giving full details of age, qualifications and experience, together with the names of two referees should be forwarded to the Manager, No. 2 (Huddersfield) Sub-Area, Yorkshire Electricity Board, Market St, Huddersfield, not later than 1 Apr., 1954.

AREA BOARD HEADQUARTERS
THIRD ASSISTANT ENGINEERS
(SYSTEM CONTROL)—(SHIFT)

Engineers are required for training as Distribution System Control Engineers. Applicants should have had reasonable practical experience in the operation of large distribution systems operating at voltages up to 33 kV and should be Corporate Members of the Institution of Electrical Engineers, or possess equivalent qualifications.

Candidates who, after training, are found suitable will be appointed as System Control Engineers (Grade 4, AX-DX, £763/£976) to staff new Control Centres which are to be set up in the area.

Salary—N.J.B. Grade AX-DX5, commencing within the range £649/£790 per annum rising to £858 per annum.

Applications, giving full details of age, qualifications and experience, together with the names of two referees should be forwarded to the Secretary, Yorkshire Electricity Board, Wetherby Rd, Scarcroft, Leeds, not later than 1 Apr., 1954.

No. 4 (LEEDS) SUB-AREA
GENERAL ASSISTANT ENGINEER
(SPECIALIST SALES)

Applicants should have a sound technical and wide practical experience of electrical installation work in commercial, domestic and industrial premises. They must be competent to advise consumers in particular on water and space heating installations.

Possession of Higher National Certificate will be an advantage.

Salary—N.J.B. Class K, Grade 13, £583/£605 per annum.

WEATHERBY DISTRICT
ASSISTANT CONSUMERS' ENGINEER

Applicants should have had a sound practical training in electrical installation work and preferably experience in the work of a Consumers' Engineer's Department.

The successful applicant will be required to undertake negotiations with consumers requiring electricity supplies and deal with tariffs, sales development, application of I.E.E. wiring regulations and other relevant regulations in testing and inspecting consumers installations.

Possession of the Higher National Certificate in Engineering will be an advantage.

Salary—N.J.B. Class E, Grade 10, £555/£569 per annum.

SUB-AREA HEADQUARTERS
ENGINEERING DRAUGHTSMAN
(ELECTRICAL)

Applicants should be competent draughtsmen with good general and technical educa-

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tion and should preferably have had experience in the preparation of substation layout drawings and electrical diagrams.

Salary—N.J.B. Schedule D, £433/£567 per annum.

Applications, giving full details of age, qualifications and experience, together with the names of two referees should be forwarded to the Manager, No. 4 (Leeds) Sub-Area, Yorkshire Electricity Board, Bramhope, Nr. Leeds, not later than 1 Apr., 1954.

No. 7 (GRIMSBY) SUB-AREA
GRIMSBY DISTRICT
ASSISTANT INSTALLATION ENGINEER

Applicants should have a good technical background and possession of the Higher National Certificate in Electrical Engineering would be an advantage. They must have had practical experience in the supervision of domestic, agricultural and industrial installation work including the preparation of estimates and tenders.

Salary—N.J.B. Class F, Grade 10, £577/£598 per annum.

Applications, giving full details of age, qualifications and experience, together with the names of two referees should be forwarded to the Manager, No. 7 (Grimsby) Sub-Area, Yorkshire Electricity Board, Moss Rd, Grimsby, not later than 1 Apr., 1954. (H 216)

## BRITISH ELECTRICITY AUTHORITY
### South Western Division

FIRST ASSISTANT STATION CHEMIST required at Castle Meads Generating Station.

Superannuation Scheme. Salary, N.J.B. Class "E," Grade 9, £587/£600.

Applicants should preferably hold H.N.C. in Chemistry and be prepared to further their technical education. They should have had experience of modern power station laboratory techniques in fuel, water and oil analysis, and be familiar with the objects and methods of water treatment on power plant.

Applications on Form A.E.6/ACT, obtainable from the Divisional Secretary, 26 Oakfield Rd, Bristol 8, should be completed and returned by 31 Mar., 1954. (H 201)

## BRITISH ELECTRICITY AUTHORITY
### South Eastern Division

ASSISTANT ENGINEER (Instruments). Brighton "B" Power Station. Applicants should preferably possess Higher National Certificate and must be experienced in the maintenance, testing and calibration of all types of Power Station instruments. A knowledge of electronics would be an advantage. N.J.B. Conditions of Service. Class J, Grade 12. £596 per annum. Applications, giving details of education, present position, experience, etc., should be sent to the Station Superintendent, Brighton Power Station, Portslade-by-Sea, Sussex, by 27 Mar., 1954. (H 219)

## BRITISH ELECTRICITY AUTHORITY
### Merseyside and North Wales Division

APPLICATIONS are invited for the appointment of STATION SHIFT CONTROL ENGINEER at the Southport Power Station, Russell Rd, Southport. Salary £531/£547 per annum. Class D, Grade 10. N.J.B. Superannuable and subject to medical examination.

Applicants should have had a good general and technical education and experience in the control room of a modern power station. Possession of Higher National Certificate or equivalent qualifications would be an advantage.

Application Forms are obtainable from the Divisional Secretary, Beaconsfield Rd, Woolton, Liverpool. Closing date: 26 Mar., 1954. (H 208)

## SOUTH WESTERN ELECTRICITY BOARD
### 2nd Assistant District Engineer, Exeter

CANDIDATES should have experience of construction and maintenance of overhead line works, and supervision of line survey. Possession of appropriate technical qualifications and driving licence desirable. Application Forms from District Manager, 46 North St, Exeter, to be returned within 10 days. (H 214)

## THE NORTH EASTERN ELECTRICITY BOARD

APPLICATIONS are invited for the following appointments, all subject to N.J.B. Agreement for Electricity Supply Industry.

(TYNE SUB-AREA)

FIRST ASSISTANT DISTRICT COMMERCIAL ENGINEER with location at Blyth Service Centre. Applicants should be suitably qualified electrical engineers with experience in all aspects of service to domestic, commercial and smaller industrial consumers. Salary, Class E, Grade 6, £699/£725.

(WEAR SUB-AREA)

SECOND ASSISTANT ENGINEER with location at Sub-Area Headquarters. Applicants should be qualified engineers and must have had extensive experience in all classes of electrical engineering operation and maintenance work. Salary, Class L, Grade 7, £926/£966.

GENERAL ASSISTANT ENGINEER, Construction Section, with location at Sub-Area Headquarters. Salary, Class L, Grade 13, £616/£646.

THIRD ASSISTANT DISTRICT ENGINEER with location at Sunderland District. Salary Class F, Grade 9, £607/£629.

Applications, stating age, qualifications and experience, should be forwarded to the Secretary (Establishments), The North Eastern Electricity Board, Carliol House, Newcastle upon Tyne, within ten days of the appearance of this advertisement. (H 215)

## BRITISH ELECTRICITY AUTHORITY
### Generation Construction

SUB-DEPARTMENT Headquarters, London, require a PRINCIPAL ASSISTANT ENGINEER (Co-Ordination) to supervise engineers co-ordinating Power Station construction work in several Divisions. Duties include visits to Power Stations and attendance at site meetings. Practical experience in Modern Power Station construction, including handling of contracts, preparation of commissioning programmes, work on site and co-ordination of projects from inception to commissioning is essential. Candidates should preferably be Corporate Members of the I.E.E. or I.Mech.E. Salary N.J.M. Scale 4, £1,650/£1,800 including London Allowance.

Applications stating age, qualifications and experience, present position and salary to D. Moffat, Director of Establishments, British Electricity Authority, Winsley St, London, W.1, by 29 Mar., 1954. Quote reference ET/463. (H 194)

## BRITISH ELECTRICITY AUTHORITY
### Yorkshire Division

APPLICATIONS are invited for the following appointments:

POWER STATION SUPERINTENDENT
KIRKSTALL POWER STATION, LEEDS

Salary £1,235/£1,289 per annum, Class H, Grade 1. N.J.B. Agreement.

Applicants should have had wide experience in the operation and maintenance of large modern power station plant, including pulverised fuel fired boilers, and have held a position of responsibility involving the control of staff.

ASSISTANT CHEMIST
DIVISIONAL HEADQUARTERS, LEEDS

Commencing salary within the scale £501/£639 per annum according to qualifications and experience, rising to an ultimate maximum of £694 per annum.

Candidates should hold the Higher National Certificate in Chemistry and have had a good general analytical experience. Knowledge of the examination of polluted waters would be considered advantageous.

The successful candidate will be stationed at Skelton Grange Power Station, Leeds, and will be required to assist on general work associated with river surveys within the Division.

Application forms obtainable from Divisional Secretary (Establishments), British Electricity Authority, Yorkshire Division, St. Mary's Rd, Leeds, 7, to be returned within fourteen days of the appearance of this advertisement.

G. A. VOWLES,
Divisional Controller.
(H 211)

## BRITISH ELECTRICITY AUTHORITY
### East Midlands Division

APPLICATIONS are invited for the following positions within the Division:

ENGINEERING DRAUGHTSMEN (CIVIL)
CONSTRUCTION DEPARTMENT
Vacancy No. 1/54

Candidates should have experience in design and detail of reinforced concrete structures, piled and slab foundations for heavy plant, culverts, cable subways, etc., for general building construction drainage and sanitation schemes, associated with official and administrative buildings.

The salary will be in accordance with Grade 5 (£567/£671 per annum) or Grade 6 (£433/£567 per annum) of Schedule D of the National Joint Board Agreement.

ENGINEERING DRAUGHTSMEN (MECHANICAL)
CONSTRUCTION DEPARTMENT
Vacancy No. 2/54

Senior Draughtsmen are required in the Mechanical Section of the Construction Department at North Wilford Power Station. Candidates should have experience in one or more of the following:

(i) Design and layout of Power Station equipment, including turbo-alternators, boiler plant, coal and ash plant, and general station auxiliaries.
(ii) H.P. and L.P. steam and feed pipework. Condensing plant and feed heating systems.
(iii) Conveyor plant, coal handling systems and material handling of station auxiliary equipment.

The salary will be in accordance with the National Joint Board Agreement Grade 5 (£567/£671 per annum) and Grade 6 (£433/£567 per annum) of Schedule D according to experience.

ENGINEERING DRAUGHTSMEN (ELECTRICAL)
CONSTRUCTION DEPARTMENT
Vacancy No. 3/54

Candidates should have experience in the preparation and layouts and diagrams for the installation of E.H.T. and L.T. Switchgear, transformers, E.H.T. and L.T. cables; knowledge of protective gear systems would be an advantage.

The salary will be in accordance with the National Joint Board Agreement Grade 5 (£567/£671 per annum) and Grade 6 (£433/£567 per annum) of Schedule D according to experience.

STATION SHIFT CONTROL ENGINEERS
DRAKELOW POWER STATION
Vacancy No. 28/54

The minimum requirements are possession of the Higher National Certificate in electrical and/or mechanical engineering, together with experience in the control and load despatching of large capacity steam generating plant connected to the National Grid System.

Salary in accordance with Class J, Grade 10 (£680/£706 per annum) of the National Joint Board Agreement.

The closing date for receipt of applications is 26 Mar., 1954.

DEPUTY POWER STATION SUPERINTENDENT
DRAKELOW POWER STATION
Vacancy No. 29/54

Applicants should be corporate members of the Institution of Mechanical and/or Institution of Electrical Engineers, and have had experience in a responsible position with the operation and maintenance of modern large capacity high pressure plant employing pulverised fuel boilers.

The successful applicant should also possess sound administrative and organising ability.

Salary in accordance with N.J.B. Schedule, Class J, Grade 3 (£1,104/£1,156 per annum).

The closing date for this appointment is 26 Mar., 1954.

THIRD ASSISTANT ENGINEER (MECHANICAL)
CONSTRUCTION DEPARTMENT,
NORTH WILFORD POWER STATION
Vacancy No. 35/54

Applicants should have had fundamental training in mechanical engineering, including workshops, and should preferably have had experience in the manufacture, erection, maintenance and operation of mechanical plant as installed in modern power stations. Candidates should possess a University

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Degree or equivalent qualification in mechanical engineering.

The duties of this position will be the supervision of the installation of plant at North Wilford Power Station.

The salary for this appointment will be within Class AX/DX, Grade 5, Schedule C (£649/£858 per annum) of the National Joint Board Agreement.

The closing date for this appointment is 26 Mar., 1954.

SHIFT CHARGE ENGINEER
STAYTHORPE POWER STATION
Vacancy No. 36/54

Applicants must have had a sound technical training and considerable experience in a modern generating station. Preference will be given to candidates who are Corporate Members of the Institution of Electrical or Mechanical Engineers, or who hold similar qualifications.

The salary will be in accordance with Class J, Grade 7, of the National Joint Board Schedule (£817/£852 per annum).

A house will be available for the successful applicant.

The closing date for receipt of applications is 26 Mar., 1954.

ASSISTANTS TO THE DIVISIONAL CHIEF CHEMIST
Vacancy No. 37/54

Applications are invited for two positions as Assistants to the Divisional Chief Chemist.

Salaries and conditions will be in accordance with the National Joint Board Agreement, Schedule C, as under:

(A) Grade 5—£649/£790/£858
(B) Grade 8—£501/£639/£694

Candidates for post (A) should hold the B.Sc. degree in chemistry or equivalent qualification; candidates of a lower standard will be considered for post (B). Power Station experience is not essential but applicants should have had previous industrial experience in one or more of the following fields:

Air pollution; river pollution; fuel analysis; industrial water treatment; lubrication; inorganic analyses, metallurgy or metallography, applied statistics; corrosion.

Post (A) is located in Nottingham and post (B) (temporarily) at Staythorpe near Newark, Notts.

The closing date of receipt of applications is 5 Apr., 1954.

The above positions will be pensionable within the provisions of the British Electricity Authority and Area Boards Superannuation Scheme.

Applications should be submitted on the official form which may be obtained from the Divisional Establishments Officer, British Electricity Authority, Barker Gate, Nottingham, and should be returned to the undersigned by the date stated. Please quote Vacancy Number.

L. F. JEFFREY,
Divisional Controller.
(H 217)

## BRITISH ELECTRICITY AUTHORITY
### Eastern Division

APPLICATIONS are invited for the following post:

JUNIOR ENGINEER
CLIFF QUAY GENERATING STATION

Salary Class K, Grade 19, £402 p.a.—Grade 15, £545 p.a.

Commencing salary depending on qualifications and experience.

The duties of the successful applicant will include assisting in the Control Room on shift and other operation and investigation duties. Preference will be given to applicants who have had previous experience in a Generating Station and who have reached the standard of the Ordinary National Certificate in Electrical Engineering or its equivalent.

Applications stating age, qualifications and experience, should be sent to the Controller, British Electricity Authority, Eastern Division, Northmet House, Southgate, N.14, by 27 Mar., 1954.

W. N. C. CLINCH,
Controller.
(H 199)

## CITY OF BELFAST—ELECTRICITY DEPARTMENT

APPLICATIONS are invited, from persons of not more than 45 years of age, for the following positions:

(a) ASSISTANT GENERATION ENGINEER

Qualifications: A University Degree in Electrical Engineering or Corporate Membership of the Institution of Electrical Engineers, plus a sound engineering training and extensive experience in power station operation and management.

Duties: Assisting in the supervision of three generating stations having a present combined capacity of 244 MWs and an ultimate capacity of 424 MWs.

(b) TURBINE ROOM MECHANICAL MAINTENANCE ENGINEER

Qualifications: A University Degree or the Higher National Certificate in Mechanical Engineering or Corporate Membership of the Institution of Mechanical Engineers, together with a workshop training, preferably with a manufacturer of large turbines, and experience in a responsible position in the erection, maintenance and testing of steam-driven turbines and mechanical auxiliary plant appertaining to a large modern power station.

(c) SENIOR TECHNICAL ASSISTANT (MECHANICAL)
(d) SENIOR TECHNICAL ASSISTANT (ELECTRICAL)

Applicants must have a University Degree or Higher National Certificate in Mechanical or Electrical Engineering, and preferably be Corporate Members of the Institution of Mechanical or Electrical Engineers respectively. They must have had a sound engineering training and good practical experience in all phases of handling contracts and supervising progress of construction work in connection with mechanical and electrical plant respectively for large steam power stations. The positions offer scope for progress and only candidates with first class qualifications will be considered.

(e) ASSISTANT CIVIL ENGINEER

Qualifications: A University Degree, Diploma, or Higher National Certificate, in Civil Engineering or Associate Membership of the Institution of Civil Engineers or Structural Engineers plus a sound engineering training and good practical experience.

All the above posts are remunerated in accordance with the Northern Ireland Joint Board Schedule of Salaries for Technical Engineers on the Staff of Authorised Undertakers in the following classes and grades:

(a) £1,104/£1,130/£1,156 (Grade 3, Class J).
(b), (c) and (d) £833/£850/£866 (Grade 6, Class H).
(e) £885/£904/£923 (Grade 5, Class H).

Superannuation contributions will be payable at the rate of approximately 6% of remuneration.

Preference given to suitably qualified ex-Servicemen.

Canvassing will disqualify.

Applications, on the official forms obtainable from the Electricity Department, East Bridge St, Belfast, must reach the undersigned not later than Friday, 9 Apr., 1954.

JOHN DUNLOP,
Town Clerk.
City Hall, Belfast. (H 207)

## MERSEYSIDE AND NORTH WALES ELECTRICITY BOARD

SYSTEM CONTROL ENGINEER (SHIFT) required in the No. 4/5 Sub-Area Operation Department based on the Control Centre at Legacy, near Wrexham. Salary £680/£706 p.a. (N.J.B. Class J, Grade 10).

Duties, which will be on a continuous shift basis, will be those normally associated with switching operations and load transfers on an extensive E.H.V. system inter-connecting 132/33 kV injection points and a number of hydro-electric stations.

Applicants should have had operational experience in distribution work and in substations. Possession of the technical qualifications necessary to enable them to become Chartered Electrical Engineers advantageous.

Standard application forms obtainable from the Manager, No. 4/5 Sub-Area, Electricity House, Rhostyllen, near Wrexham. Closing date: 29 Mar., 1954. (H 200)

## SOUTH EAST SCOTLAND ELECTRICITY BOARD
### Lothians Sub-Area

THIRD ASSISTANT ENGINEER required in the Planning and Technical Section at Sub-Area Headquarters, Musselburgh.

The duties include the commissioning and testing of protective gear, the calculation of relay settings and fault powers and the high voltage testing of cables and switchgear. Experience in the operation of supervisory equipment involving telephone type equipment would be an advantage. Technical Education to the Higher National Certificate standard is essential. N.J.B. Class G. Grade 10. £608/£630 per annum. Superannuation Scheme.

Application, by letter, stating age, education, qualifications and experience with details of present appointment and salary should be submitted to the Sub-Area Manager, South East Scotland Electricity Board, High Street, Musselburgh, within fourteen days. (H 114)

## BRITISH ELECTRICITY AUTHORITY
### Merseyside and North Wales Division

APPLICATIONS are invited for the position of ASSISTANT CLERK OF WORKS (Mechanical) at the Connah's Quay Power Station, North Wales, which is in course of construction. Salary will be at the rate of £11 per week and the appointment will be temporary in the first place.

The successful applicant will be required to assist in supervising the correct and proper installation by contractors of the high pressure boilers, turbines and associated auxiliary plant in the station, and will be selected with a view to his suitability for engagement at a later date on the operating staff of this or other stations in the Division.

Applicants should preferably have practical experience in the erection and/or maintenance of a large engineering plant preferably steam boilers and turbines.

Application Forms from the Divisional Secretary, Beaconsfield Rd, Woolton, Liverpool. Closing date: 27 Mar., 1954. (H 196)

## CITY OF BIRMINGHAM PUBLIC WORKS DEPARTMENT
### Applications are invited for the post of Electrical Engineering Assistant in the Mechanical Section

APPLICANTS for the post should have passed Part I of the Institution of Electrical Engineers Associate Membership Examination or hold an equivalent qualification. They should have had experience in the design and specification of electric lighting, power and heating installations for large public buildings, etc.

Commencing salary, Grade A.P.T. IV (£580/£625 per annum), will be in accordance with qualifications and experience.

The post is permanent, superannuable, subject to a medical examination and to one month's notice on either side.

Applications endorsed "Electrical Engineering Assistant (A.P.T. IV)" stating qualifications, age and experience, together with the names of two persons to whom reference can be made should reach the undersigned not later than 27 Mar., 1954.

Canvassing disqualifies.

HERBERT J. MANZONI,
City Engineer and Surveyor.

Civic Centre,
Birmingham 1. (H 195)

## BRITISH ELECTRICITY AUTHORITY
### South Wales Division

Vacancy No. 25/54

APPLICATIONS invited for superannuable N.J.B. appointment of ASSISTANT SHIFT CHARGE ENGINEER at Tir John Power Station, Swansea. Salary H.9, £680/£706 per annum.

H.N.C. and regular apprenticeship desirable. Operating experience in a modern generating station essential.

Application forms obtainable from Secretary, South Wales Division, British Electricity Authority, Twyn-y-fedwen Rd, Gabalfa, Cardiff, to be returned by 29 Mar., 1954. (H 237)

## EASTERN ELECTRICITY BOARD

APPLICATIONS are invited for the following appointments:

CHILTERNS SUB-AREA

*Hemel Hempstead District.* 23/54.R

GENERAL ASSISTANT ENGINEER

Candidates should have had a sound technical training and experience in the construction, operation and maintenance of H.V. and L.V. overhead and underground systems in both urban and rural areas.

The salary will be in accordance with Class E, Grade 11, of the National Joint Board Salary Agreement, commencing at £524.

Apply to the District Manager, Hemel Hempstead, 44 Marlowes, Hemel Hempstead, Herts.

*Luton District.* 6/54.R

ASSISTANT ENGINEER (COMMERCIAL)

Candidates must have experience of tariffs associated with Industrial and Commercial consumers and must be able to advise on and estimate for installations in such consumers' premises including power factor correction. A knowledge of street lighting would be a particular advantage. Preference will be given to those holding the Higher National Certificate in Electrical Engineering.

The salary will be in accordance with Class G, Grade 9, of the National Joint Board Salary Agreement, commencing at £641.

Apply to the District Manager, Luton, Eastern Electricity Board, 487 Dunstable Rd, Luton, Beds.

Previously advertised in January 1954. Applications submitted on that occasion need not be repeated.

SUFFOLK SUB-AREA

*Ipswich District.* 26/54.R

DEMONSTRATOR

Candidates should have had Domestic Science training including Electrical Housecraft, should preferably hold the E.A.W. Certificate and be competent to plan and give cookery demonstrations, including lectures and advice to consumers on the utilisation of domestic electrical appliances. Previous experience in an Electricity Service Centre is desirable.

Salary will be in accordance with Grade 1 (£400 by £20—£480 by £10—£490) of the National Joint Council Salary Agreement, although progress beyond £440 will be subject to a certificate that the person concerned is capable of undertaking all the duties of the grade.

Apply to the District Manager, Ipswich, Eastern Electricity Board, Electric House, Ipswich, Suffolk.

Future salary and conditions of service for the above appointments will be in accordance with agreements made from time to time by the appropriate negotiating bodies.

The successful candidate will be required to contribute to a superannuation scheme and may be required to undergo a medical examination.

Applications, by letter, stating age, education, qualifications and experience, with detail of present appointment and salary, should be submitted to the Manager concerned within fourteen days of the appearance of this advertisement. (H 209)

## BRITISH ELECTRICITY AUTHORITY
### London Division

APPLICATIONS are invited for the following superannuable posts, conditions of service in accordance with N.J.B. Agreement, Schedule A or C. Salary includes London Allowance. Qualifications entitling to Graduate Membership of the I.E.E. or I.Mech.E. for posts (a) and Corporate Membership for posts (b), an advantage.

(b) MAINTENANCE ENGINEER (ELECTRICAL)
BLACKWALL POINT GENERATING STATION

Sound technical training followed by practical experience in the repair and maintenance of modern power station electrical plant. Salary Class F, Grade 6=£774. 18s. p.a.

(a) ASSISTANT MAINTENANCE ENGINEER (MECHANICAL)
BLACKWALL POINT GENERATING STATION

Sound engineering training with experience

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in the repair and maintenance of modern generating plant. Salary Class F, Grade 9 =£637. 7s. p.a.

(a) INSTRUMENT ENGINEER
WEST HAM GENERATING STATION

Experience necessary in maintenance, testing and calibration of all types of power station electrical and mechanical instruments. Salary Class H, Grade 12=£593. 5s. p.a.

(a) SHIFT CHARGE ENGINEER
ST. MARYLEBONE GENERATING STATION

Practical experience of Power Station operation and maintenance. Salary Class E, Grade 7=£681. 9s. p.a.

(b) DEPUTY BOILER HOUSE SUPERINTENDENT
DEPTFORD EAST GENERATING STATION

Sound mechanical training with wide experience in the efficient operation and maintenance of Boiler House and auxiliary plant. Salary Class H, Grade 7=£810. 12s. p.a.

(a) THIRD ASSISTANT ENGINEER (EFFICIENCY AND TESTING)—DIV. H.Q.

Candidates should have a degree in engineering. Experience in a power station, in an industry using large furnaces or experience in technical investigations, particularly in the measurement of radiant heat associated with the determination of furnace performance would be an advantage. Commencing salary will depend upon experience and ability, within the scale, £681. 9s. to £927. 3s. p.a. in accordance with Schedule C, Grade 5.

(a) GENERAL ASSISTANT ENGINEERS (EFFICIENCY AND TESTING)—DIV. H.Q.

Graduate Technical education necessary with experience of the testing and/or operation of mechanical plant in a Power Station. Salary Schedule C, Class AX/EX, Grade 8 =£526. 1s./£670. 19s. p.a. rising ultimately to £749. 14s. p.a.

(a) JUNIOR ENGINEER
TECHNICAL DEPARTMENT

Experience in manufacture and testing of electrical equipment used in Generating Stations and High Voltage Transmission Systems. Experience in commissioning and maintenance of such equipment, including protective gear, an added qualification. Salary Schedule C, Class AX/EX, Grade 9 =£415/£551. 5s. p.a. rising to ultimate maximum of £618. 9s. p.a.

Application, quoting vacancy number, may be made on form obtainable from Divisional Secretary, B.E.A., London Division, Generation House, Great Portland St, W.1, and be received within 14 days of this advertisement. (H 213)

## COUNTY BOROUGH OF BLACKPOOL
### Appointment of Senior Technical Assistant

APPLICATIONS are invited for the superannuable appointment, in the Electrical Services Department, of a Senior Technical Assistant (A.P.T. VII) (£735 x £25 to £810). The post is subject to special conditions as to office hours, particulars of which may be had on application.

Candidates must have had a sound technical training with experience in electricity distribution, street lighting and/or lighting engineering and possess administrative ability.

Applications, giving particulars of age, present position, full details of qualifications and experience, including names and addresses of two referees, to be forwarded to the Illuminations and Public Street Lighting Officer, Electrical Services Department, Rigby Rd East, Blackpool, to reach him not later than 10 Apr., 1954.

Canvassing, or the submission of the names of members of the Blackpool Council as referees, will disqualify candidates.

TREVOR T. JONES,
Town Clerk.
(H 236)

WANTED: SENIOR FOREMAN
Must be capable of taking charge of large contracts in Town and Country.
Must hold E.T.U. Ticket.
Write giving full particulars to:
**RASHLEIGH PHIPPS & CO., LTD.**
Electrical Engineers,
Esmond Court, Thackeray St,
Kensington, W.8. (H 123)

### BRITISH ELECTRICITY AUTHORITY

HEADQUARTERS require a CIVIL AND BUILDING DESIGN ENGINEER in the Transmission Construction branch. The person appointed will be responsible to the Transmission Construction Engineer for all matters relating to the design and construction of the building and civil engineering work of the Authority's transmission system.

Salary N.J.M. Scale 5, £1,800 x £50 to £1,950 inclusive.

Letters of application stating age, qualifications, experience, present position and salary to D. MOFFAT, Director of Establishments, British Electricity Authority, Winsley St, London. W.1, by 2 Apr., 1954. Quote reference E.T./462. (H 202)

APPLICATIONS are invited from young men aged about 25 years of O.N.C. standard who are interested in technical commercial work concerned with domestic and household appliances in the Sales organisation of the GENERAL ELECTRIC CO., LTD. Some experience in this type of work would be an advantage but a good personality and keenness for hard work are essential. Apply in writing giving full details and quoting "Ref. D.E." to the Staff Manager, Magnet House, Kingsway, W.C.2. (H 227)

AN ASSISTANT ELECTRICAL ENGINEER for installation and maintenance work, age 23 to 26 years. Candidates should hold a University Degree in Electrical Engineering and have served a Graduate Apprenticeship. A knowledge of instrumentation, automatic control and electronics would be advantageous. The post is at our Yorkshire Factory, but replies should be addressed to the CHIEF PERSONNEL OFFICER, Pilkington Brothers Ltd., St. Helens, Lancashire. (H 228)

APPLICATIONS are invited by THE ENGLISH ELECTRIC CO., LTD., Stafford, from YOUNG ENGINEERS of Graduate or Higher National Certificate standard with experience in the preparation of control gear wiring diagrams, for training as control gear engineers on specialised schemes. Selected applicants will, where necessary, be given a short course of training and will receive full pay during this period. The positions are permanent and progressive and afford excellent opportunities. Apply quoting ref. 1245A to Dept. C.P.S., 336/7 Strand, W.C.2. (H 188)

ARMATURE WINDERS (Skilled—male) urgently required to meet continued expansion. Good rates with special bonus. Overtime. Permanency. W. MACKIE AND CO., LTD., 129 Lambeth Rd, S.E.1 (Nr. Lambeth Bridge). (H 192)

A BIRMINGHAM wholesaler, old established, E.W.F. and R.W.F., requires ELECTRICAL REPRESENTATIVE to call on large users and contractors. Pension and Life Assurance scheme. Car provided or allowance paid. Write stating salary required and past experience to—Box No. 3357, Electrical Times. (H 129)

APPLICATIONS are invited for the posts of OVERHEAD LINESMEN to be located in the Drakelow Area. Experience of 132 kV steel tower lines essential. Conditions and wages in accordance with N.J.I.C. Schedule. Applications, stating age, experience, etc., should be submitted through Ministry of Labour, to Divisional Establishments Officer, BRITISH ELECTRICITY AUTHORITY, Barker Gate, Nottingham. Please quote Vacancy No. 9/54. (H 107)

APPLICATIONS are invited for the posts of OVERHEAD LINESMEN to be located at a Transmission Section near Coventry. Experience of 132 kV Steel tower lines essential. Conditions and wages in accordance with N.J.I.C. Schedule. Applications, stating age, experience, etc., should be submitted through Ministry of Labour to Divisional Establishments Officer, BRITISH ELECTRICITY AUTHORITY, Barker Gate, Nottingham. Please quote Vacancy No. 34/54. (H 108)

AN Electrical Engineering firm in South London require an engineer for their Transformer Sales Office. Ordinary National Certificate in Electrical Engineering standard. Apply in writing stating age, experience and qualifications.—Box No. 3337, Electrical Times. (H 67)

A VACANCY exists with a firm of Cable Makers for a young electrical Engineer of H.N.C. or degree standard who has completed his apprenticeship and who has a leaning towards the commercial side. Apply with brief details of career to—Box No. 3325, Electrical Times. (H 2)

DRAUGHTSMAN, electric elements and thermal devices. To take control of experimental Drawing Office and records. Some knowledge of press work and tools. An opportunity. Five day week, canteen, pension scheme. Very healthy location. State briefly age, experience, technical training, salary, and whether married with family, to Works Manager, BEST PRODUCTS LTD., Felixstowe, Suffolk. (H 203)

ELECTRICAL ENGINEER required for Electrical Department of Works in the North-East. Should have a sound practical training, drawing office experience, a knowledge of motor control gear resistor calculations, and preferably some experience of electrical heating for industrial applications. Apply giving full details of experience, technical qualifications, age, whether married or single, and salary required to—Box No. 3349, Electrical Times. (H 119)

ELECTRICAL Contracting, Estimating and Supervising ENGINEER required by old established firm, Westminster. Applicants should have had a thorough practical and technical training together with installation design and estimating experience; will consider up-grading capable men lacking only Estimating experience.

Salary in accord with ability and experience, Pension Schemes.

Applicants to give age, qualifications and details of experience, etc., and salary required.—Box No. 3361, Electrical Times. (H 131)

ENGINEER fully experienced in modern methods of The Thermal Efficiency Testing of Hot Water Heating and Domestic Boiler and Stoves, required by large industrial firm in East Anglia. Contributory Pension Scheme and Free Life Assurance Scheme in operation. Applications stating age, education, experience and salary required to—Box No. 3395, Electrical Times. (H 224)

ENGINEERING Company considering manufacture of D.C. and A.C. marine motors and control gear require the services of a young qualified ELECTRICAL ENGINEER and designer to take complete charge of a new department. Write stating age, qualifications and salary required to—Box No. 3385, Electrical Times. (H 190)

INFORMATION OFFICER required to assist in technical information service for research, engineering and commercial departments of a large electrical engineering firm in the north-west. Technical qualifications in engineering essential. Previous experience in industrial information work and a knowledge of French or German would be advantageous. Salary will depend on qualifications and experience and will be progressive. Write giving full particulars including age, sex, nationality, education and experience, marking envelope "Information Officer," to—Box No. 3366, Electrical Times. (H 156)

INSTRUMENTS ASSISTANT is required by IMPERIAL SMELTING CORPORATION LIMITED for work in Research Department. Candidates should possess Higher National Certificate in Physics, Electrical or Mechanical Engineering with 3 years' experience in light electro-mechanical development. Commencing salary will be fixed according to qualifications and experience of individual candidates. Applications to Personnel Manager, St. Andrew's Rd, Avonmouth, quoting reference AI/E.T. (H 231)

### GOVERNMENT OF KUWAIT

JUNIOR SHIFT ENGINEERS required for service with the Government of Kuwait, Persian Gulf. Their services are required for a new Steam Power Station and a Water Distillation Plant. They will be required to work on shift under the Shift Charge Engineers. Applicants must have experience in Steam Power Station operation and have some technical qualification. Applicants should not be more than 35 years of age. The starting consolidated salary offered is at the rate of £1,500 per annum. Free furnished quarters and free medical attention are provided. The first year will be probationary and subject to satisfactory service this contract may be extended by another two years. Married accommodation cannot be promised under one year. Applications in the first instance, stating qualifications, training and experience, to be addressed to the Secretary, EWBANK AND PARTNERS LIMITED, Engineering Consultants, 10/11 Grosvenor Place, London, S.W.1. (H 167)

LABORATORY ENGINEER. Required by a fast expanding firm in Stevenage, LABORATORY ENGINEER, B.SC. or H.N.C. standard for work on interesting project involving servo control with magnetic amplifiers. Experimental ability and flair for design essential. Experience with magnetic amplifiers very desirable. The post is progressive. Housing and Pension scheme available. Write Box No. 3353, Electrical Times. (H 125)

JOINTER (E.H.T.) required by LONDON ELECTRICITY BOARD in Finsbury/Shoreditch district. N.J.I.C. rates and conditions. 4s. per hour. Application forms from Personnel Officer, 46 New Broad St, E.C.2. Please enclose addressed envelope and quote ref. M.2860/T. (H 223)

LEADING Manufacturers have vacancy in their Domestic Electric Appliances Department at Head Office in London for perience of stock control and correspondence CAPABLE ASSISTANT (Age 30/35). Exalso some knowledge of buying and selling required. Excellent opening for young man with initiative eager to get on. Apply—Box No. 3403, Electrical Times. (H 238)

LABORATORY ENGINEER. Required by a fast expanding firm in Stevenage, LABORATORY ENGINEER, B.SC. or H.N.C. standard for work on electromagnetic devices, relays and solenoids. Must have experimental ability and flair for design. Experience with electro magnetic devices essential. The post is progressive. Housing and Pension Scheme available. Write—Box No. 3355, Electrical Times. (H 126)

LAMP SALESMAN required for Lancashire area, residence in Manchester District and previous experience essential. Age under 35. Staff Pension Scheme. Apply in writing giving details to District Manager, THE BRITISH THOMSON-HOUSTON CO., LTD., 15, Quay St, Manchester 3. (H 181)

MANCHESTER CORPORATION. JUNIOR ENGINEER required on temporary staff in the Street Lighting Section of the City Surveyor and Engineer's Department. salary in Grade A.P.T. III of the N.J.C. Scales £550/£595 per annum. Applicants must have sound practical experience in the installation and maintenance of electric street lighting and the maintenance and repair of traffic signals. Possession of the Higher National Certificate or Ordinary National Certificate in Electrical Engineering or equivalent qualification will be an advantage. Applications giving details of age and experience to the City Surveyor, Town Hall, Manchester 2, by 5 Apr., 1954. (H 234)

MANAGERESS required for important Midland showrooms of large distributors of Electric Lighting and Domestic equipment. Excellent opportunity for lady with ability to sell, organise and co-operate with others. Applications in writing in confidence in first instance, stating age, experience, salary, married or single. Eventual choice will be by personal interview.—Box No. 3383, Electrical Times. (H 189)

MAINTENANCE ELECTRICIANS required for large Paper Mill. Sound experience of large A.C. and D.C. motors and switchgear essential. BOWATER'S THAMES PAPER MILLS Ltd., Northfleet, Gravesend, Kent. (H 183)

OUTSIDE SERVICE REPRESENTATIVES required by Electricity Meter manufacturer, London. Knowledge and experience in calibration and handling of single and polyphase meters, P.P. meters and M.D.I. meters and equipment. Good general and technical education; specialised training given in company's products. Previous O.S. experience not essential—Write, giving full particulars, including present salary, to—Box No. 3389, Electrical Times. (H 193)

PROCESS SUPERINTENDENT required for Rubber and Thermoplastic Cable factory in Manchester area. This is a responsible position offering good prospects to a man aged 30 to 40, familiar with rubber cable technique and design. Applicants must be capable of maintaining quality standards for all operations and should possess the energy and drive necessary to promote efficient manufacture of new products and successful introducing of new manufacturing processes. Good salary and pension scheme. Apply—Box No. 3387, Electrical Times. (H 191)

PROGRESS in manufacturing methods and techniques in connection with heavy rotating electrical machines and Mercury Arc Rectifiers have led to several interesting vacancies in THE ENGLISH ELECTRIC CO., LTD., Stafford, for MANUFACTURING OR METHODS ENGINEERS and PRODUCT DEVELOPMENT ENGINEERS. Applications are invited from engineers working in either of these capacities and from those who have a sound background of practical experience in a manufacturing industry, at least O.N.C. and a desire to enter either of these important branches of engineering. Please write quoting ref. 1225A, to Dept. C.P.S., 336/7 Strand, W.C.2. (H 225)

REPRESENTATIVE required by well established manufacturers of high grade switches to cover Northern Counties. Contact with Area Boards and leading industrial organisations an advantage and one or two other agencies in electrical line not objected to. Reply giving full details including experience and remuneration expected to—Box No. 3347, Electrical Times. (H 118)

SALES ENGINEER (Inside) required immediately by a firm of the highest standing for A.C. and D.C. motors and capacitors for industrial application. N.E. London Area, pension scheme. Write giving full particulars of education, experience and salary required to—Box No. 3397, Electrical Times. (H 226)

SALES ENGINEERS, D.C. and A.C. motors and control gear, required London, Manchester and Birmingham areas, outside sales experience essential. Apply in writing only to Sales Director, VERITYS LTD., Brettenham House, Strand, London, W.C.2. (H 184)

YOUNG ELECTRICAL ENGINEER required for supervising lighting and power installations, preferably with breakdown knowledge. Write, stating previous experience, age, and salary required, to—Box No. 3359, Electrical Times. (H 130)

YOUNG ENGINEER required by large Engineering concern for outside erection work connected with High Voltage Substations. Successful applicants will be initially stationed in South-East England, but must ultimately be prepared to travel throughout the U.K. Minimum requirements are O.N.C. in Electrical Engineering plus some experience of Erection Work. Applications to—Box No. 3401, Electrical Times, quoting Ref. A.B.G.H. (H 235)

**Box No. replies to be addressed to the ELECTRICAL TIMES, Sardinia House, Sardinia Street, London, W.C.2.**

WANTED: COSTING CLERK
Required, able to prepare accounts for contracts, previous similar experience essential, Write full particulars and salary required to:
**RASHLEIGH PHIPPS & CO., LTD.**
Electrical Engineers,
Esmond Court, Thackeray St,
Kensington, W.8. (H 124)

**Installation Inspecting Engineer**

THE National Register of Electrical Installation Contractors, 13 Victoria St, London, S.W.1, invite applications for the above post. The work concerned is the inspection of electrical installations carried out by applicants for registration with this Registrar and re-inspections of the work of contractors who are already on this Register. The location of the work is north of a line drawn from Kings Lynn to Barmouth. A considerable amount of travelling is involved. The applicant should live in the North of England.

The salary offered is £750 p.a. rising to £800 plus travelling and subsistence allowances. A contributory Pension Scheme exists. The applicant will be required to pass a medical examination and should not be more than 35 years of age. A sound knowledge of the I.E.E. Wiring Regulations is essential and the applicant must have had practical experience in electrical installation work.

Applications to be addressed to The Secretary, National Register of ELECTRICAL INSTALLATION CONTRACTORS, 13 Victoria St, London, S.W.1, giving age and full particulars of training and experience. (H 187)

THE ASSOCIATED ETHYL COMPANY LIMITED, Northwich, Cheshire, wish to appoint to their Engineering Department two ASSISTANT ELECTRICAL ENGINEERS. One appointment will be to the Design and Engineering Section and one to the Works Maintenance Section.

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Manager.

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W. H. WARHURST,
Secretary.

London Electricity Board,
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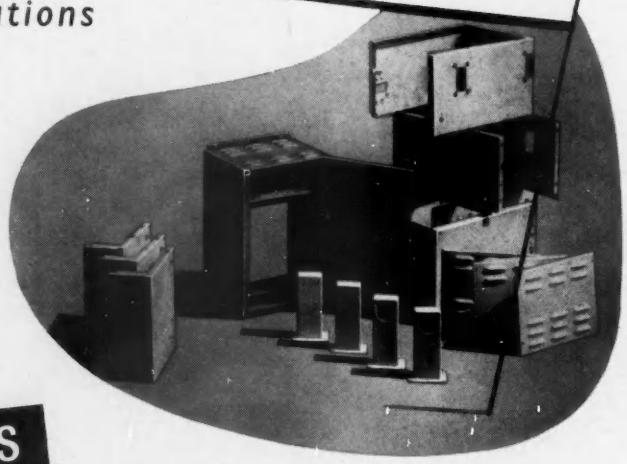

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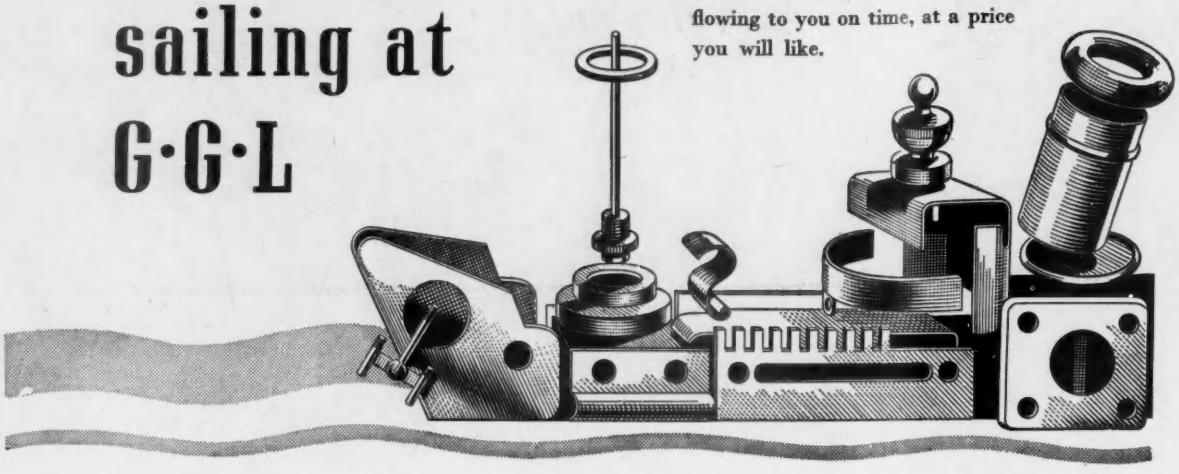

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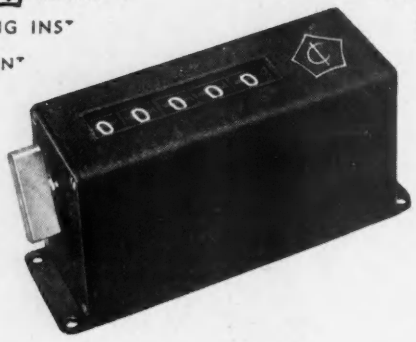

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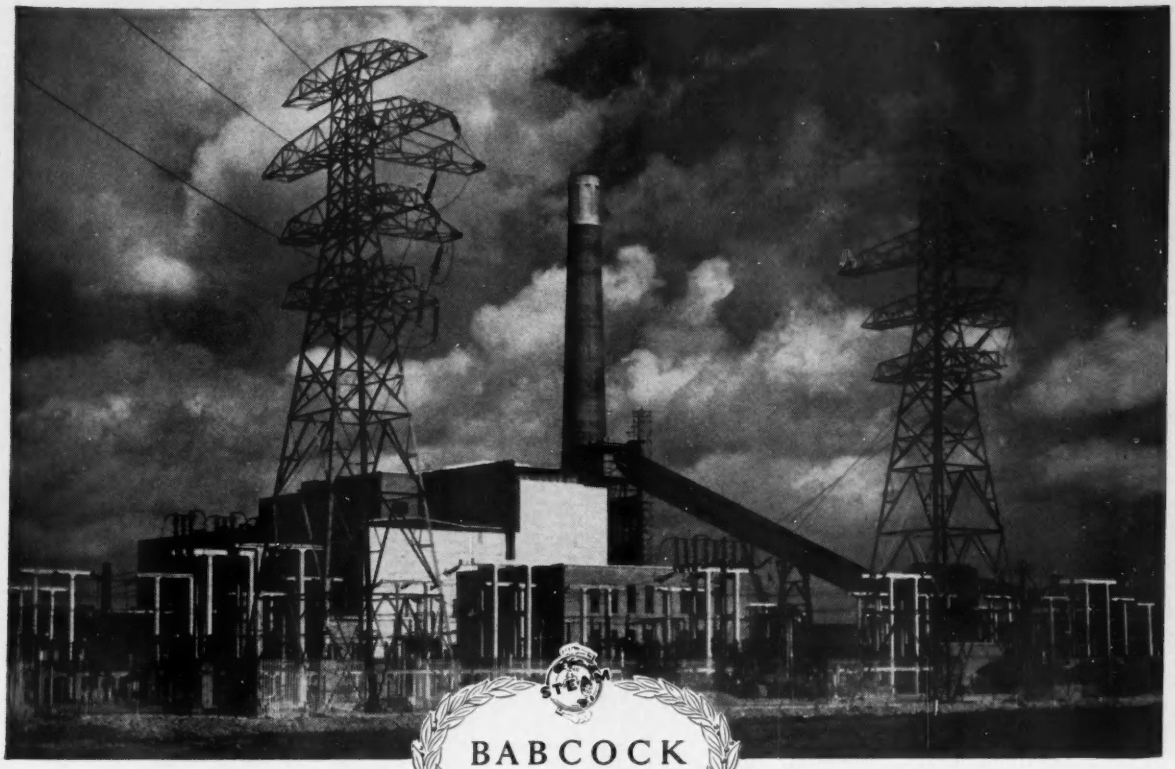


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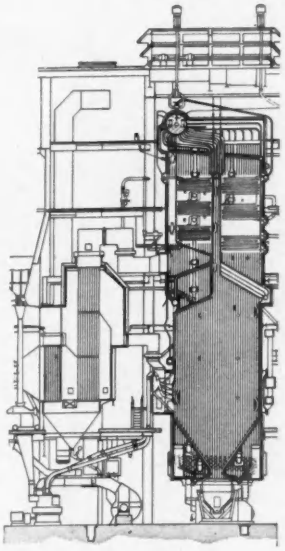

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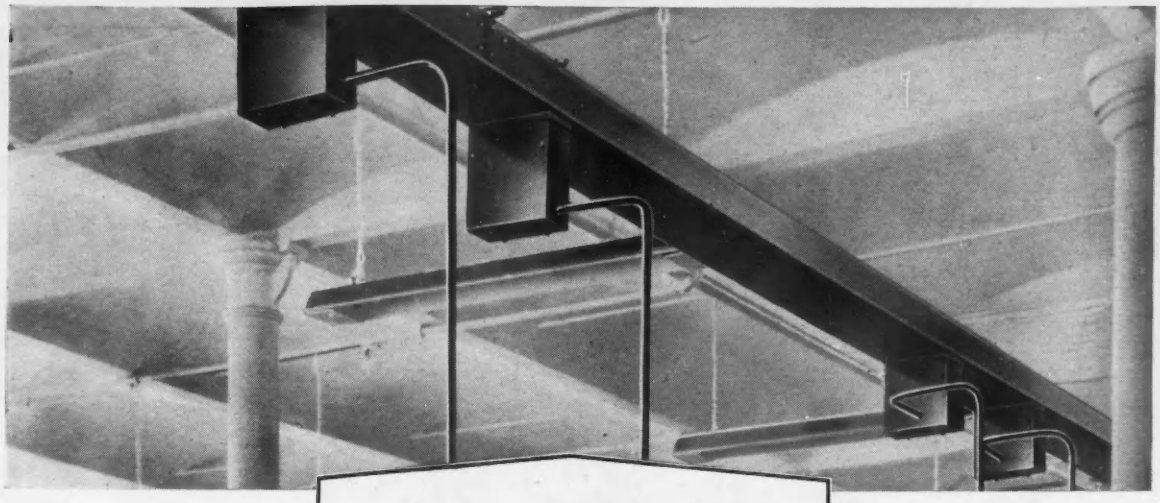

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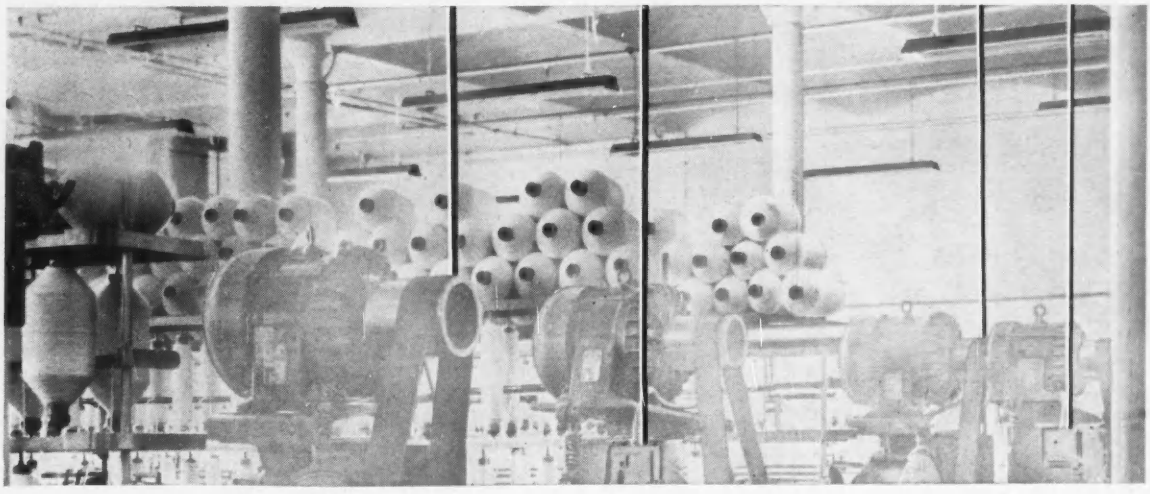

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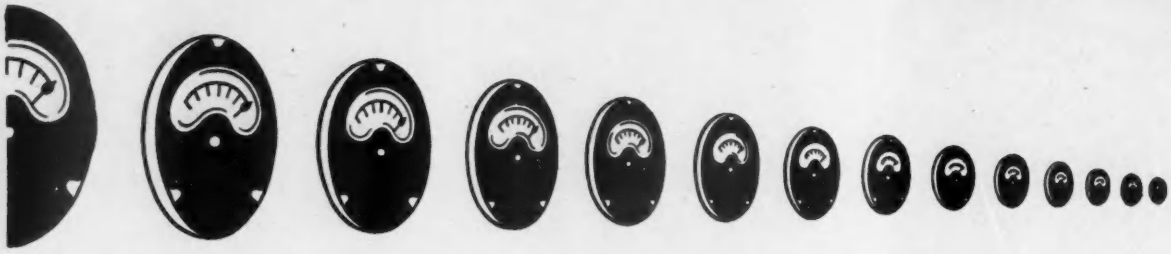

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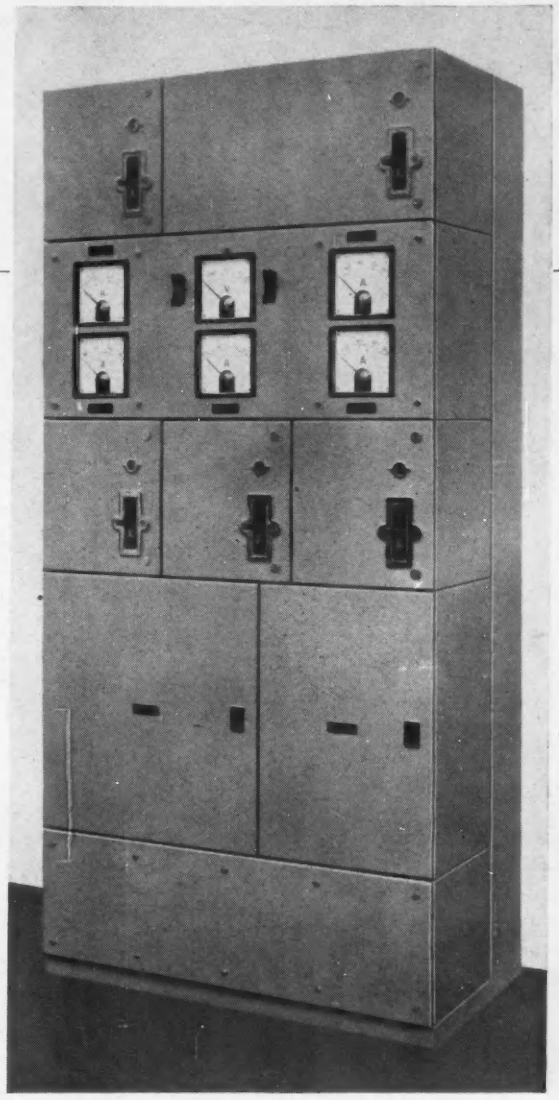

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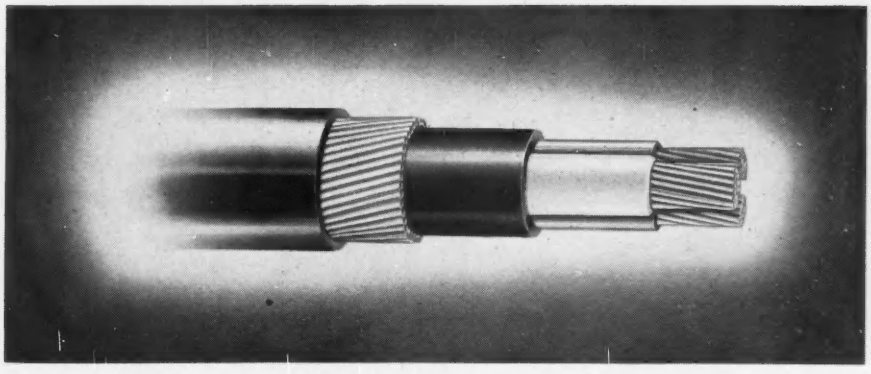

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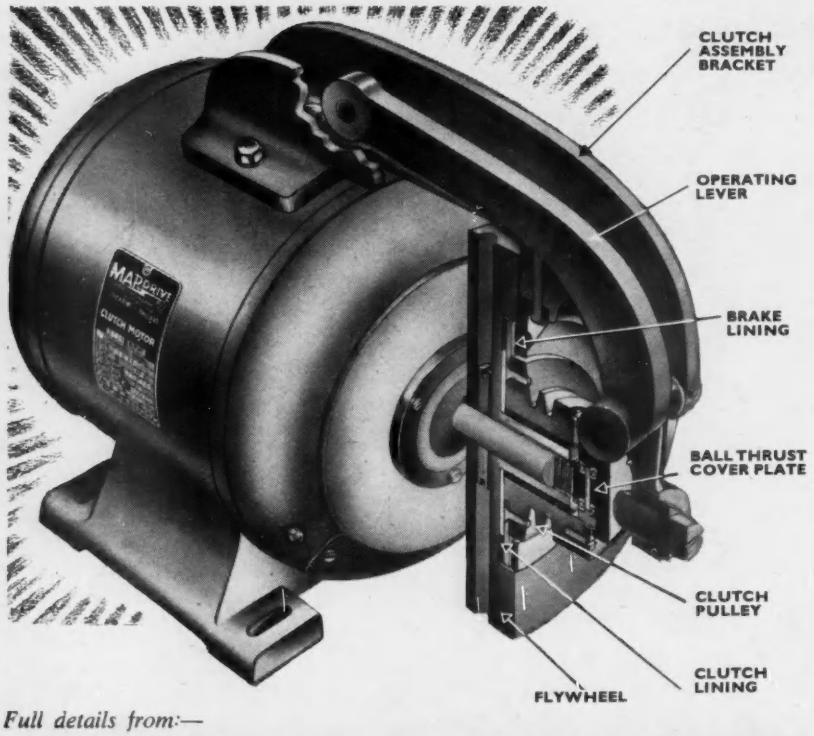


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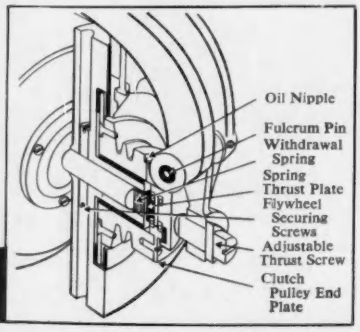


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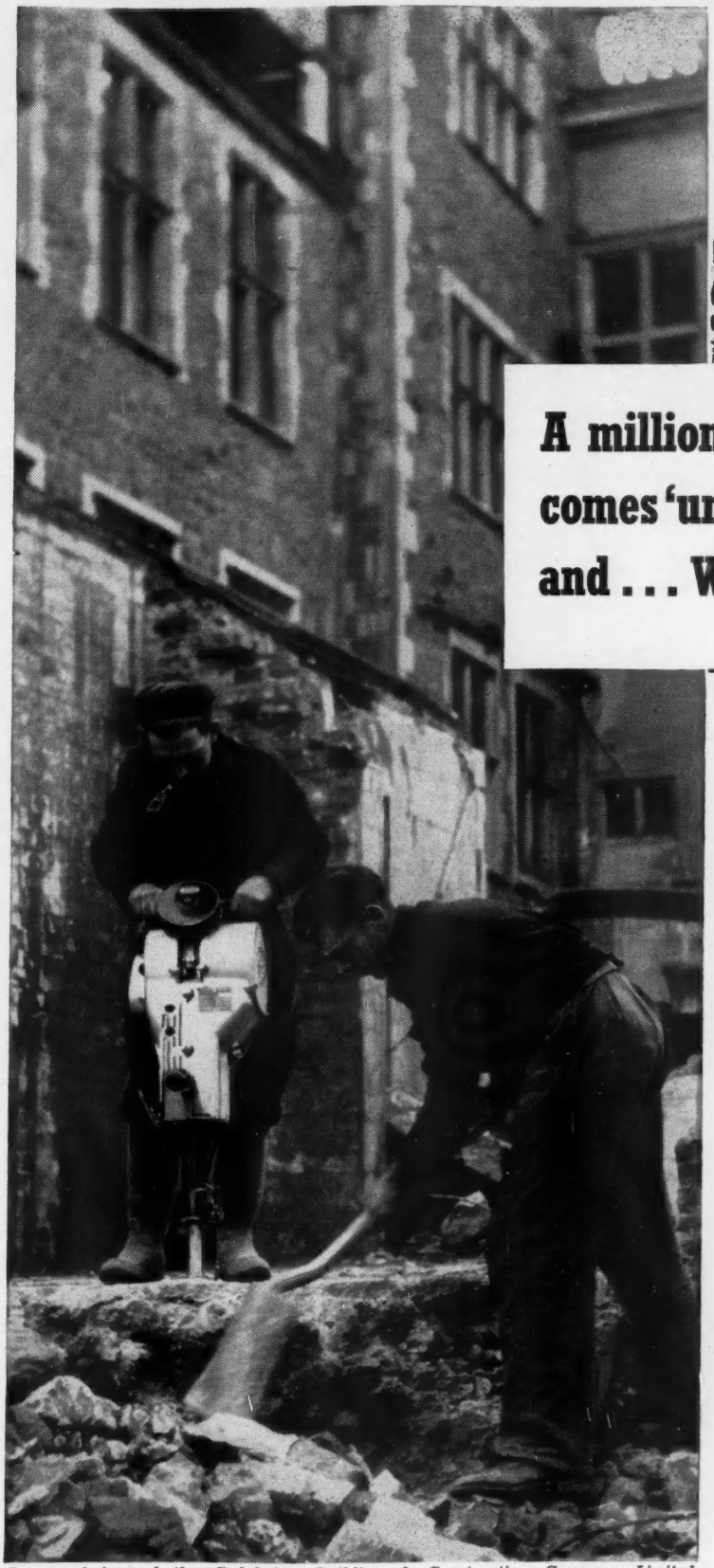

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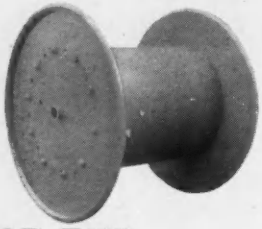

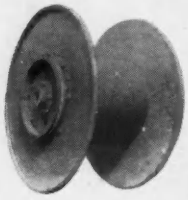

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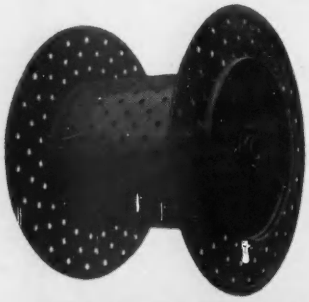

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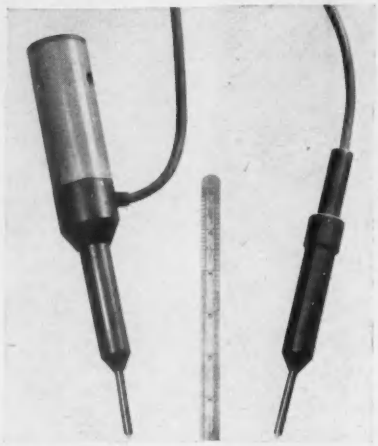

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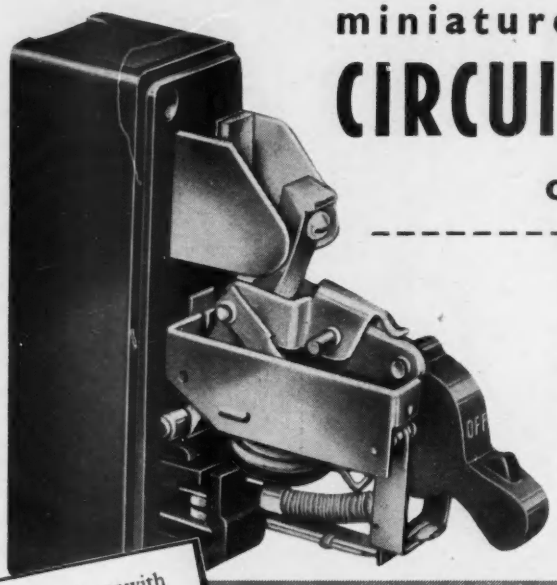

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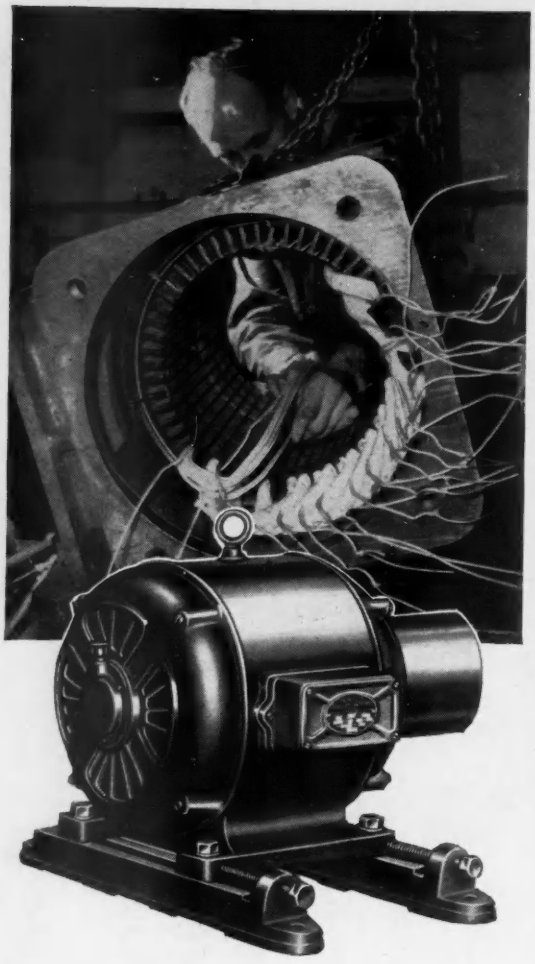

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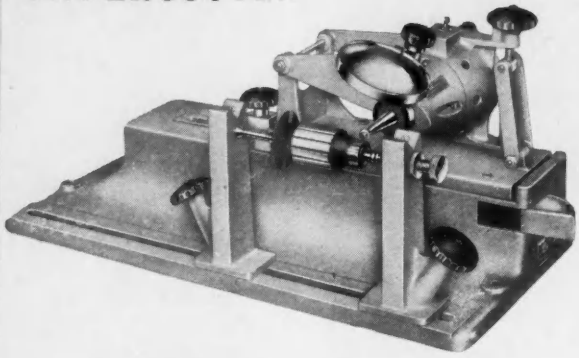

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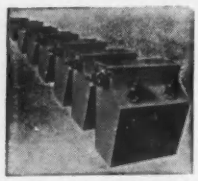

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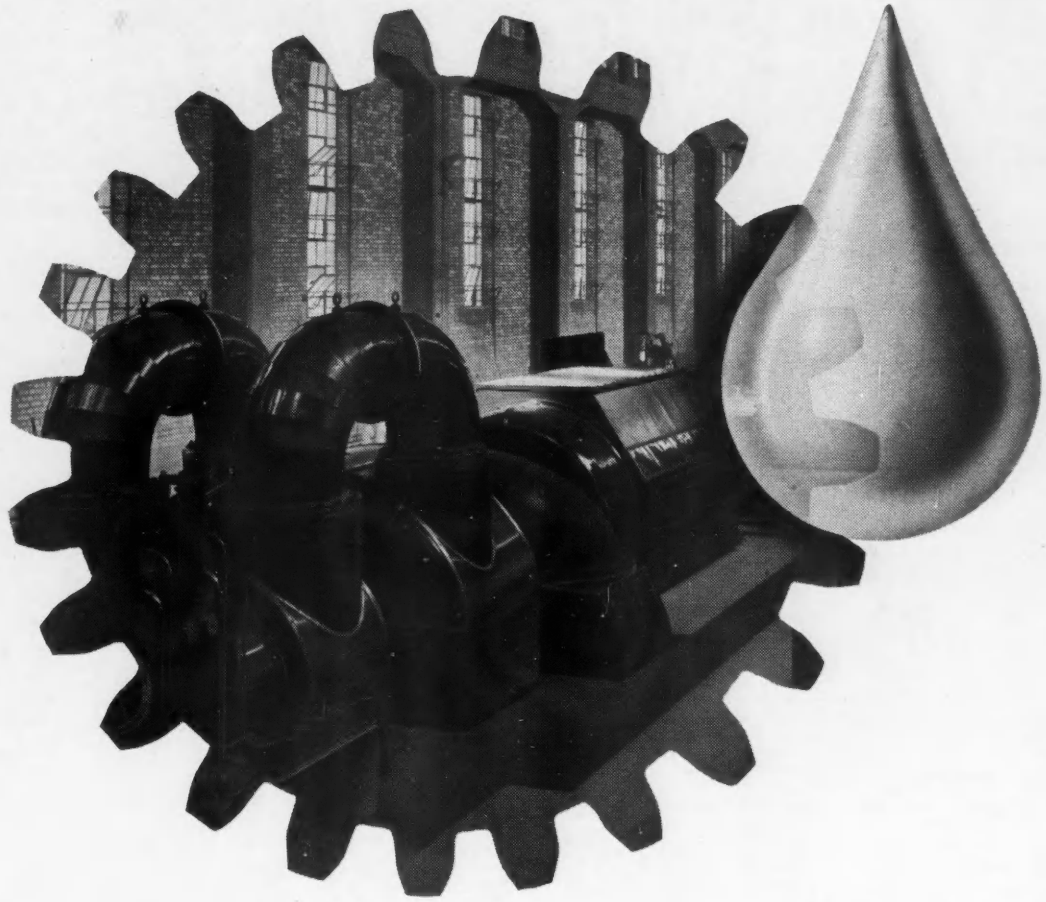

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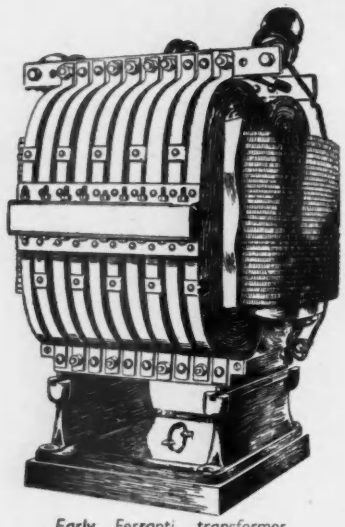

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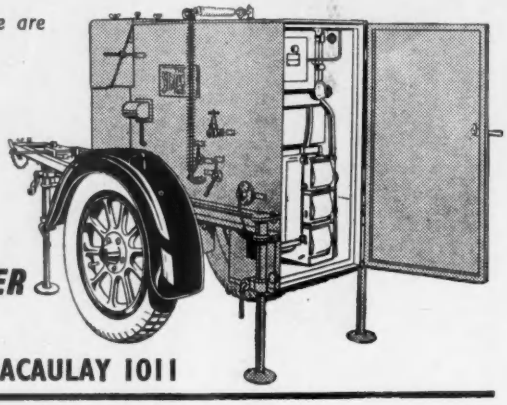

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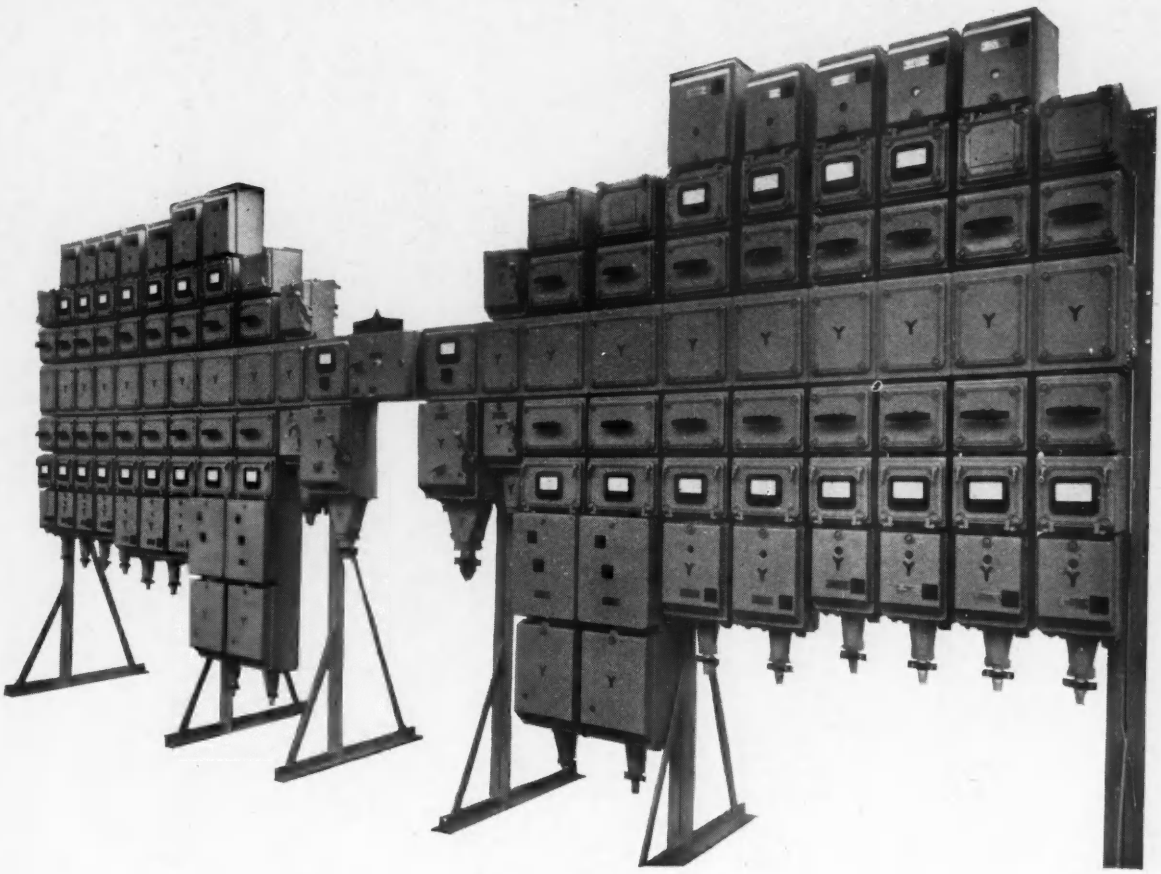

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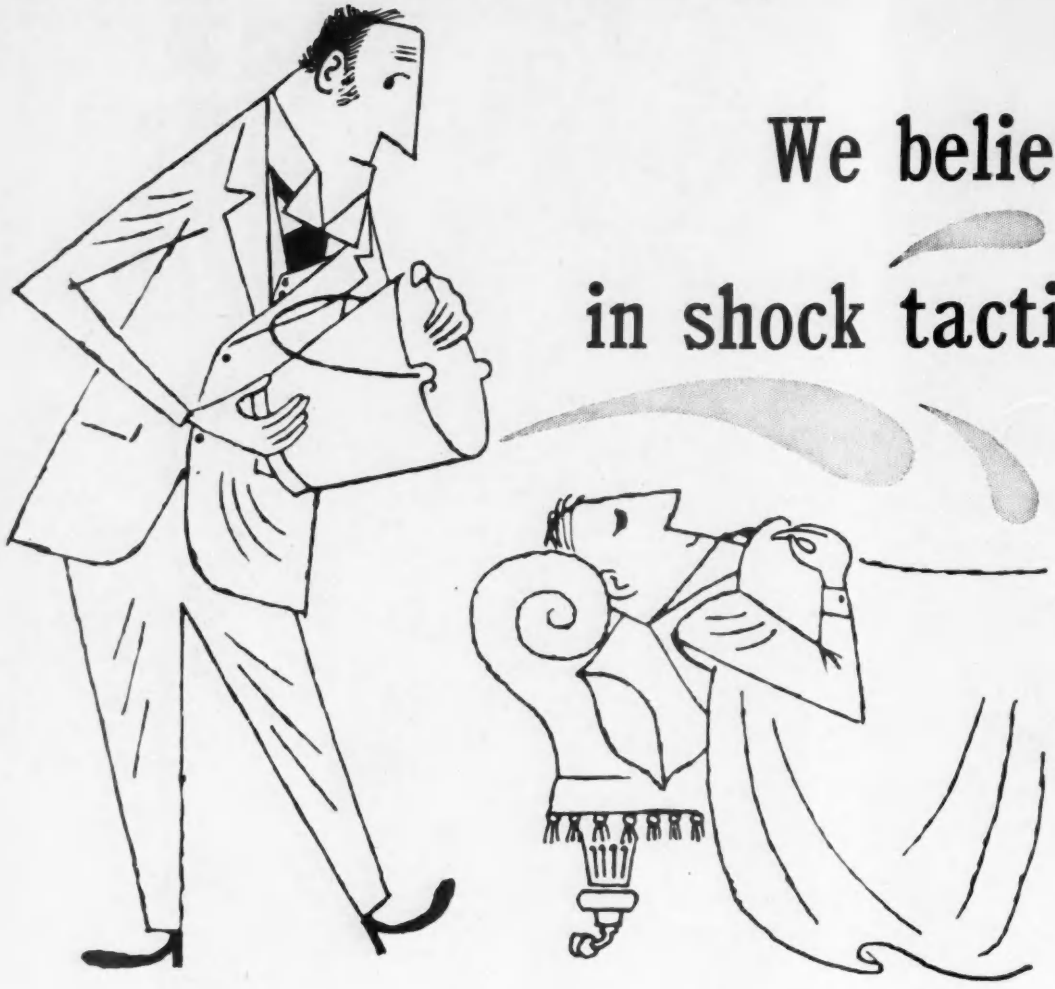

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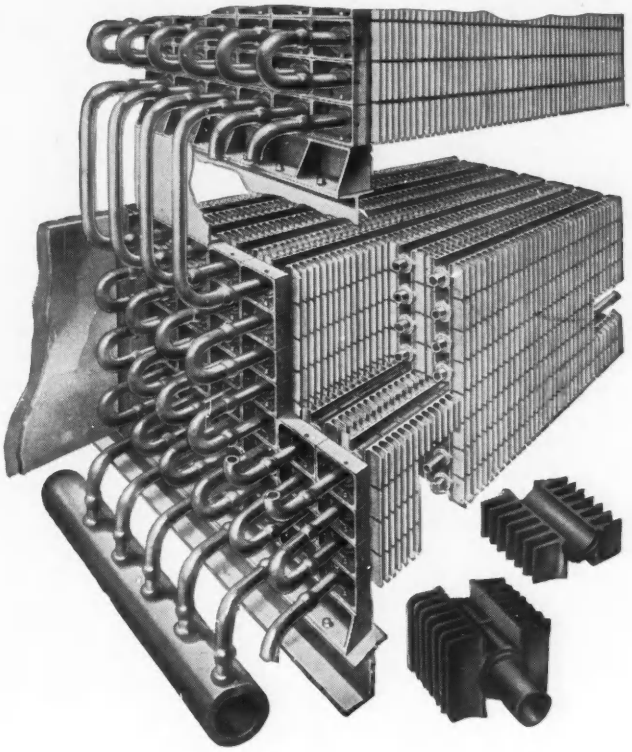
*For waste heat recovery at highest pressures*

# SENIOR *welded* ECONOMISER



The illustration shows the construction of the tube elements in the Senior Welded Economiser, as used in modern Generating Stations. Maximum heat transfer is effected by H-gilled sleeves which are shrunk on cold-drawn steel tubes, all tube joints being welded. The construction is suitable for all operating pressures.

*senior*

**ECONOMISERS LIMITED**

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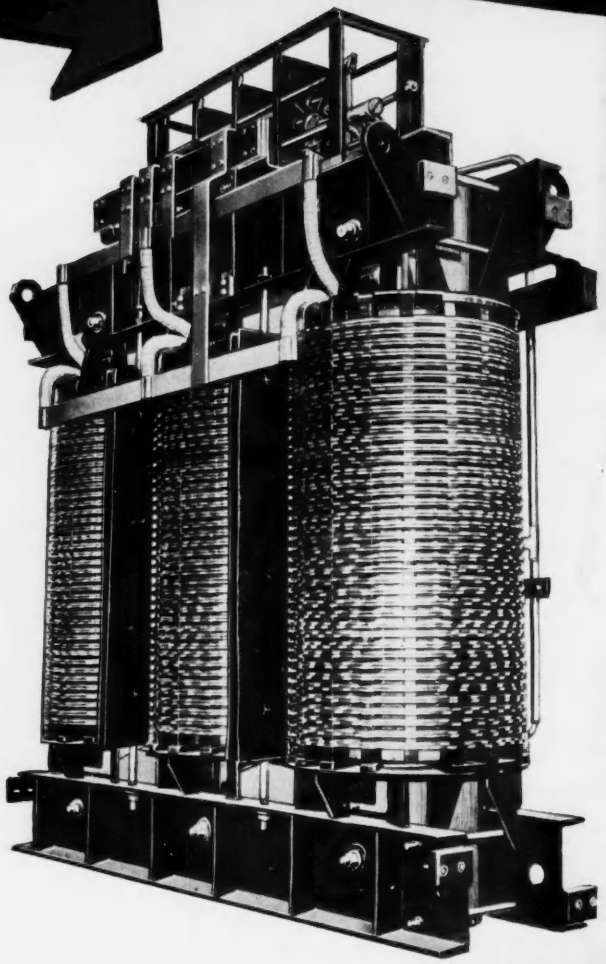
*Denis Ferranti Group*



POWER
TRANSFORMERS

**The illustration shows a 3,750 kVA 11,000/3,300 volts 50 cycles 3-phase Transformer. Similar construction is employed up to 10,000 kVA. Larger Transformers are built up to 30 MVA. 66 kV.**

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